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TABLE OF CONTENTS, VOLUME THIRTY-SIX

No. 1. October-December, 1989

Amanita eburnea — a new species from Central America. **Rodham E. Tulloss** 1

Lecanora sect. *Petrasterion* (lichenized Ascomycotina) in North America: *Lecanora weberi* Ryan, sp. nov. (subsect. *Pseudocorticatae*), from Colorado . . . . **Bruce D. Ryan** 9

Two new species of the genus *Ascochyta* Lib. **Simeon G. Vanev and Ganka G. Bakalova** 15

Type studies in marasmioid and collybioid fungi (Tricholomataceae) II. *Agaricus graminum* . . . . **Vladimír Antonín** 19

Vaccinium fungi: *Helicoma vaccinii* sp. nov. . . . . **L. M. Carris** 29

Long-chain fatty acid composition as a tool for differentiating spoilage wine yeasts . . . **M. Malfeito-Ferreira, A. St. Aubyn, and V. Loureiro** 35

Description of the anamorph of *Valseutypella multicollis* in culture. **Julia Checa and Angel T. Martínez** 43

Studies on J. B. Cleland's fungal herbarium — 2: *Cortinarius* subgenus *Myxacium* (Cortinariales) . . . . **Cheryl A. Grgurinovic** 47

Studies on *Galeropsis* and *Gastrocybe* (Bolbitiaceae, Agaricales). **G. Moreno, M. Heykoop, and C. Illana** 63

Phytophthora erythroseptica . . . . **H. H. Ho and S. C. Jong** 73

Deuteromycotina from Antarctica. New species of hyphomycetes from Danco Coast, Antarctic Peninsula . . . . **Marta N. Cabello** 91

Studies on *Pholiota* in culture . . . . **Stig Jacobsson** 95

Scientific names in the Endogonales, Zygomycotina . . **Rogério T. Almeida** 147

Contribution to the lichen flora of Brazil. XXIII. Lichens from São Paulo City . . . . **Héctor S. Osorio** 161

A new species and first record of *Gymnopaxillus* (Hymenogastrales) from Argentina . . . . **Susana Calvelo and Laura Lorenzo** 163

A taxonomic revision of the genus *Cheilymenia* — 1. Species close to *Cheilymenia rubra* . . . . **Jiří Moravec** 169

Size and shape of urediniospores as influenced by ambient relative humidity . . . . **Larry J. Littlefield and Wanda K. Schimming** 187

Nuclear DNA, an adjunct to morphology in fungal taxonomy. **R. Durán and P. M. Gray** 205

Meliolaceous fungi from the State of Kerala, India I. **V. B. Hosagoudar and R. D. Goos** 221

Cultural, enzymatic and cytological studies in the genus *Pholiota*. **Jaroslav Klán, Dana Baudišová, and Ivana Rulfová** 249

Two new *Glomus* species from arable land . . . **J. P. Skou and I. Jakobsen** 273

The genus *Pezizella* I.: nomenclature and history. **Wolf-Rüdiger Arendholz** 283

Three new species in the lichen genus *Parmelia* (Parmeliaceae, Ascomycotina) from southern Africa, with further notes. **Franklin A. Brusse** 305

No. 2. January-March, 1990

Entolomataceae in eastern North America I: new species of *Claudopus* and *Rhodocybe* from the southern Appalachian Mountains. **Timothy J. Baroni** 313

Contribution to the lichen flora of Brazil. XXIV. Lichens from Nova Petropolis, Rio Grande do Sul State. **Héctor S. Osorio and Mariana Fleig** 325

Nidulispora gen. nov., a hyphomycete genus with crateriform conidia. **A. Nawawi and A. J. Kuthubutheen** 329

A preliminary checklist of the Agaricales of Tulsa County, Oklahoma. **Estelle Levetin, Nora Jones, and Kerry Owens** 337

Teleomorph-anamorph connections and correlations in some *Xylaria* species .... **Brenda E. Callan and Jack D. Rogers** 343

First record of *Catenaria auxiliaris* in Illinois. **C. M. Stiles, D. A. Glawe, and G. R. Noel** 371

Halophytophthora, gen. nov., a new member of the family Pythiaceae. **H. H. Ho and S. C. Jong** 377

A monograph of the discomycete genus *Strossmayeria* (Leotiaceae), with comments on its anamorph, *Pseudospiropes* (Dematiaceae). **Teresita Iturriaga and Richard P. Korf** 383

Nomenclature and synonymy of *Stereum spadiceum* var. *plicatum*. **A. B. De** 455

Phoma proboscis sp. nov. pathogenic on *Convolvulus arvensis*. **Dana Kelly Heiny** 457

Taxonomical studies on Ustilaginales. V. .... **Kálmán Vánky** 473

Book Reviews .... **G. L. Hennebert** 483

R.SINGER; S. T. MOSS; Tadashi ARAI; D. MOORE, L. A. CASSELTON, D. A. WOOD, & J. C. FRANKLAND; J. A. von ARX; M. E. NOORDELOOS; R. A. SAMSON, E. S. HOEKSTRA, & C. A. N. VAN OORSCHOT; S. T. CHANG & T. H. QUIMIO; K. H. STEINKRAUS; Ingo NUSS; E. J. H. CORNER; DEUTSCHEN GESELLSCHAFT FÜR MYCOLOGIE; J. E. SMITH; D. T. GIBSON; R. WATLING & N. M. GREGORY; S. A. GUARRERA, I. GAMUNDÍ de AMOS, & D. RABINOVICH de HALPERIN; E. PARMASTO; Sheila BARRY, D. R. HOUGHTON, G. C. LLEWELLYN, & C. E. O'REAR; G. L. HENNEBERT & AL.

NOTICES:
Fourth International Mycological Congress: Second Circular 493
XI Congress, International Society for Human and Animal Mycology .. 494
Subscription price increase 495
Important change in editorial policy requiring submission of reviewers' comments 496

Author INDEX 497
INDEX to Fungous and Lichen Taxa 499
Reviewers 511
Publication Dates, MYCOTAXON Volume 35(2), 36(1) 511
Errata 512

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Vol. XXXVI October-December 1989 No. 1

CONTENTS

Amanita eburnea — a new species from Central America. Rodham E. Tulloss 1
Lecanora sect. *Petrasterion* (lichenized Ascomycotina) in North America: *Lecanora weberi* Ryan, sp. nov. (subsect. *Pseudocorticatae*), from Colorado . . . . Bruce D. Ryan 9
Two new species of the genus *Ascochyta* Lib. Simeon G. Vanev and Ganka G. Bakalova 15
Type studies in marasmioid and collybioid fungi (Tricholomataceae) II. *Agaricus graminum* . . . . Vladimír Antonín 19
Vaccinium fungi: *Helicoma vaccinii* sp. nov. . . . . L. M. Carris 29
Long-chain fatty acid composition as a tool for differentiating spoilage wine yeasts . . . M. Malfeito-Ferreira, A. St. Aubyn, and V. Loureiro 35
Description of the anamorph of *Valseutypella multicollis* in culture. Julia Checa and Angel T. Martínez 43
Studies on J. B. Cleland's fungal herbarium — 2: *Cortinarius* subgenus *Myxacium* (Cortinariales) . . . . Cheryl A. Grgurinovic 47
Studies on *Galeropsis* and *Gastrocybe* (Bolbitiaceae, Agaricales). G. Moreno, M. Heykoop, and C. Illana 63
Phytophthora erythroseptica . . . . H. H. Ho and S. C. Jong 73
Deuteromycotina from Antarctica. New species of hyphomycetes from Danco Coast, Antarctic Peninsula . . . . Marta N. Cabello 91
Studies on *Pholiota* in culture . . . . Stig Jacobsson 95
Scientific names in the Endogonales, Zygomycotina . . Rogério T. Almeida 147
Contribution to the lichen flora of Brazil. XXIII. Lichens from São Paulo City . . . . Héctor S. Osorio 161
A new species and first record of *Gymnopaxillus* (Hymenogastrales) from Argentina . . . . Susana Calvelo and Laura Lorenzo 163
A taxonomic revision of the genus *Cheilymenia* — 1. Species close to *Cheilymenia rubra* . . . . Jiří Moravec 169
Size and shape of urediniospores as influenced by ambient relative humidity . . . . Larry J. Littlefield and Wanda K. Schimming 187

[CONTENTS continued overleaf]

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[CONTENTS continued from front cover]

Nuclear DNA, an adjunct to morphology in fungal taxonomy.
R. Durán and P. M. Gray 205
Meliolaceous fungi from the State of Kerala, India I.
V. B. Hosagoudar and R. D. Goos 221
Cultural, enzymatic and cytological studies in the genus *Pholiota*.
Jaroslav Klán, Dana Baudišová, and Ivana Rulfová 249
Two new *Glomus* species from arable land . . . **J. P. Skou and I. Jakobsen** 273
The genus *Pezizella* I.: nomenclature and history.
Wolf-Rüdiger Arendholz 283
Three new species in the lichen genus *Parmelia* (Parmeliaceae, Ascomycotina) from southern Africa, with further notes.
Franklin A. Brusse 305

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AMANITA EBURNEA—A NEW SPECIES FROM CENTRAL AMERICA

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21 Lake Drive
Roosevelt, New Jersey 08555

Summary

Amanita eburnea is described as new from pine forests of Honduras and Belize.

Amanita eburnea Tulloss sp. nov. Holotypus: HONDURAS, Siguatepeque, vi.1976 M. H. Ivory s/63 (K).[1]

Etymology: *eburneus*, ivory white.

Pileus albus vel fumeus, 70 - 90 *mm in mensura diametrica, primo globosus, sed deinde qui fit late campanulatus vel plano-convexus, margine nonstriata, nonappendiculata; materies volvica absentes. Lamellae condensae, albae, liberae. Stipes* 45 - 110 × 10 - 18 *mm, albus. Volva membranacea, alba vel subflavida, vel* 45 *mm alta. Basidiae tetrasterigmaticae; fibulae absentes. Sporae* (7.0-) 8.0 - 11.0 (-12.0) × (4.8-) 5.2 - 6.5 (-7.5) µ*m, ellipsoidae vel elongatae, amyloideae.*

Amanita eburnea (Fig. 1) is a member of section *Phalloideae*. It is a medium-sized white to smoke gray mushroom with a smooth dry pileus surface and an annulate stipe. It has a membranous universal veil forming several limbs on the rounded to slightly pointed stipe base; the limbs are free for about one third of their height. Microscopic characters serving to distinguish the species are ellipsoid to elongate spores with an overall average Q of 1.58; a ramose subhymenium containing many uninflated, short hyphal elements; and rather plentiful inflated cells in the partial veil. This entity is known from pine forests in Belize and Honduras.

PILEUS: 70 - 90 mm diam, white to smoke gray, dry, globose at first, then broadly campanulate, then planoconvex to planar; margin nonappendiculate, nonstriate;

---

[1]
DTJ - private herbarium of Dr. D. T. Jenkins, University of Alabama, Birmingham, U.S.A.
IVORY - private herbarium of Dr. M. H. Ivory, Oxford Forestry Institute, University of Oxford, U.K.
K - Herbarium, Kew Botanic Gardens, U.K.

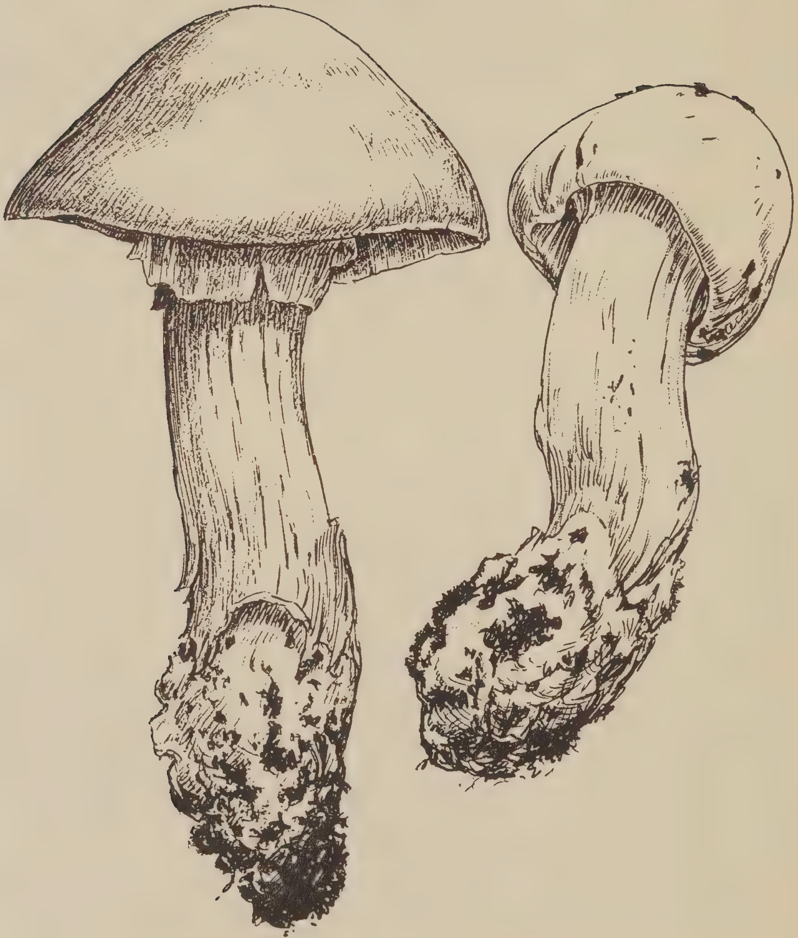

Fig. 1 *Amanita eburnea*. M. H. Ivory s/63 [×1.2].

pileipellis "papery" (Ivory); context white, firm to spongy. LAMELLAE: white, free, drying brown (6D6 or 7.5YR 5/8)[2], up to 6 mm broad, margin at times buff[3] and remaining pallid in exsiccatae. STIPE: 45 - 110 × 10 - 18 mm, white, cylindric, decorated with longitudinal striations; context white, firm to spongy, stuffed to solid; annulus white to buff, superior to subapical, membranous to submembranous, persistent or left in patches over gills or collapsing and sliding down stipe; base swollen to slender bulb, rounded or pointed below, 25± mm long; universal veil membranous, white to buff, appressed to base, limbate in several free lobes reaching to 45± mm from base of bulb, with limb free for up to 15± mm. One specimen (s/111) which was old enough to have lost its annulus, had a "moderately unpleasant smell" (Ivory).

PILEIPELLIS: filamentous undifferentiated branching hyphae 1.5 - 19.0 μm diam, gelatinizing just at surface, interwoven, not radially arranged; oleiferous hyphae 3.0 - 13.3 μm diam, with walls of the broadest thickened slightly up to 0.7 μm. PILEUS CONTEXT: tangled undifferentiated filamentous branching hyphae 1.8 - 15.0 μm diam; inflated cells ovoid, subpyriform, subglobose, plentiful, to 107 × 57 μm; branching oleiferous hyphae 1.0 - 7.5 μm diam. LAMELLA TRAMA: bilateral; frequently branching tangled filamentous undifferentiated hyphae 2.4 - 7.2 μm diam, dominating, occasionally with slightly inflated terminal segment (e.g. 56 × 10 μm) at 30°-40° to central stratum; inflated cells to 32 × 17 μm, thin-walled, intercalary, clavate to ovoid to ellipsoid; branching oleiferous hyphae present, relatively common, 2.2 - 7.0 μm diam. SUBHYMENIUM: branching chains of uninflated narrow short hyphal segments to slightly inflated short hyphal segments and ovoid to subglobose inflated cells (to 18 × 12.5 μm); basidia arising from cells of all types. BASIDIA: 37.5 - 46 × 9.7 - 11.0 μm, 4-spored, thin-walled; clamps not seen. UNIVERSAL VEIL: On the stipe base at the exterior surface: a thin layer of loosely interwoven undifferentiated filamentous branching hyphae largely without sublongitudinal orientation, 1.8 - 5.8 μm diam, at times in fascicles; some inflated terminal cells subclavate to clavate to ventricose, to 166 × 34 μm, all below the surface. On the stipe base below the surface: filamentous undifferentiated branching hyphae plentiful, 1.8 - 11.5 μm; inflated cells plentiful, ellipsoid to ovoid to subglobose (to 85 × 61 μm) and clavate (to 95 × 31 μm), occasionally with walls thickened up to 1.0 μm; oleiferous hyphae present 4.5 - 4.8 μm. On the stipe base, inner surface: extensively gelatinized, all structures similar to interior; in some regions there is a thin layer of sublongitudinally oriented hyphae. STIPE CONTEXT: acrophysalidic; branching filamentous undifferentiated hyphae 4.2 - 10.5 μm diam; oleiferous hyphae 2.8 - 7.7 μm diam; acrophysalides dominant to 315 × 64.5 μm; clamps not seen. PARTIAL VEIL: dominated by terminal inflated cells, difficult to reinflate, subglobose to ovoid (to 45 × 43 μm), subclavate to pyriform (to 82.5 × 25 μm, most less than 50 μm long) with walls infrequently thickened to 1.0 μm;

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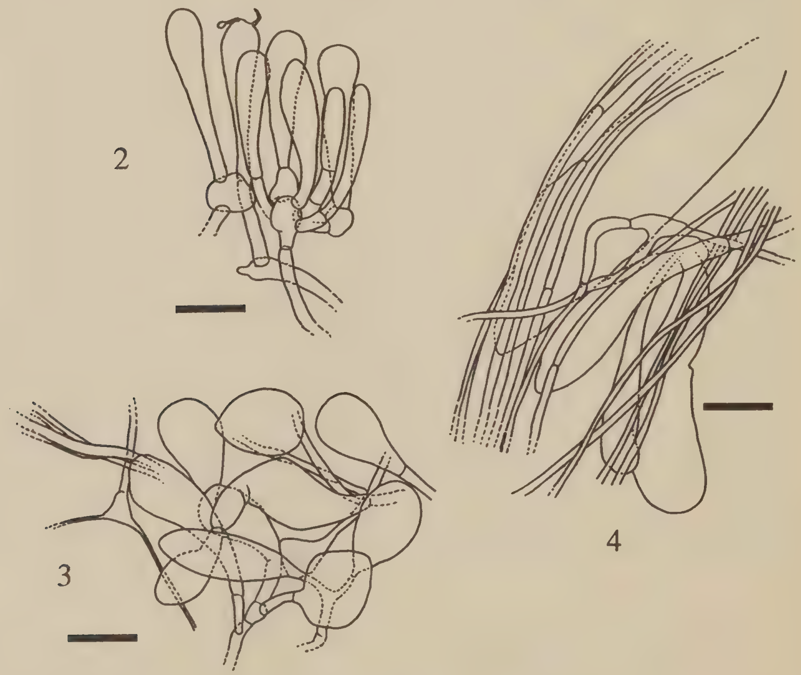
[2] Color codes of the form "6D6" are from (Kornerup & Wanscher, 1978). Color codes of the form "7.5YR 5/8" are from (Munsell Color, 1975).

[3] The color "buff" is mentioned for several parts of the fruiting body in the collector's notes. Dr. Ivory informs me (pers. corresp.) that this name was taken from Rayner (1970) in which it is noted as equivalent to the Munsell notation 1.2Y/8.1/4.1 and the ISCC-NBS name "pale yellow".

filamentous undifferentiated branching hyphae 1.5 - 7.8 μm diam, mostly quite narrow, collapsing; oleiferous hyphae present, 4.0 - 10.0 μm diam. All tissues pale yellow in 2% and 5% KOH and 10% NH_4OH.

BASIDIOSPORES: [108 from 5 specimens] (7.0-) 8.0 - 11.0 (-12.0) × (4.8-) 5.2 - 6.5 (-7.5) μm, (average length (per specimen) = 9.0 - 9.8 μm; overall average length = 9.3 μm; average width (per specimen) = 5.7 - 6.0 μm; overall average width = 5.9 μm; Q = (1.29-) 1.34 - 1.84 (-2.08); average Q (per specimen) = 1.50 - 1.66; overall average Q = 1.58), amyloid, thin-walled, hyaline, ellipsoid to elongate, rarely broadly ellipsoid or cylindrical, sometimes swollen at one end, often slightly adaxially flattened; contents guttulate; apiculus sublateral, cylindrical; white in deposit.

Distribution and habitat: Solitary to gregarious in troops under *Pinus oocarpa* Schiede & Deppe in grass on well-drained loamy soil and *P. caribaea* Mor. in bushy forest over poorly drained sandy soil, May to October, at elevations between 500 and 1100 m, in Honduras and Belize.



Figs. 2-4 *Amanita eburnea*. 2. Elements of hymenium and subhymenium (M. H. Ivory s/63). 3. Elements of partial veil (M. H. Ivory s/46b). 4. Elements of universal veil from free portion of limb near exterior surface (M. H. Ivory s/63). The bars in Figs. 2-4 represent 20 μm.

Collections examined: **BELIZE**: Augustine Forest Station, vi.1976 M. H. Ivory s/85 (K), vi.1976 M. H. Ivory s/93 (K, portion in IVORY), vi.1976 M. H. Ivory s/111 (K, portion in IVORY). **HONDURAS**: Siguatepeque, v.1976 M. H. Ivory s/46b (K, portion in IVORY), vi.1976 M. H. Ivory s/63 (holotype K, isotype with faded color photograph in IVORY).

DISCUSSION

The amyloid spores, nonappendiculate pileus margin and membranous volva on an expanded stipe base require *A. eburnea* to be placed in section *Phalloideae* (Bas, 1969). Five white taxa of section *Phalloideae* described from North America have spores of approximately the size or shape of those from *A. eburnea* (Jenkins, 1986). The group with similar values of overall average Q include the following (values in parentheses obtained from (Jenkins, 1986)):

— *Amanita parviformis* (Murrill) Murrill (1.40) - a small mushroom with pileus about 25 mm diam described from Florida (U.S.A.), differing from *A. eburnea* by having few inflated cells in its universal veil tissue, having an annulus composed exclusively of hyphae, and having spores 7.8 - 9.4 × 5.5 - 6.3 µm (based on study of the type by Jenkins (1979));

— *Amanita gwyniana* Coker (1.45) - a small mushroom with pileus up to 40 mm diam described from North Carolina (U.S.A.). differing from *A. eburnea* by having markedly rounded ends to the lamellae at the pileus margin, having a distinct odor of chloride of lime, and having spores 9.2 - 11.0 × 6.5 - 7.4 µm (based on the protologue (Coker, 1927));

— *Amanita hygroscopica* Coker (1.47) - described from North Carolina (U.S.A.), differing from *A. eburnea* by having lamellae that become pinkish with maturity, having a subhygrophanous pileus, having an annulus that is subsuperior to submedian (Coker, 1917: pl. 17 and 18), and having spores 9.0 - 12.2 × 6.2 - 8.1 µm (Jenkins (1986) states that the characters of lamellae and pileus here cited for *A. hygroscopica* are quite distinctive in *Amanita*);

— *Amanita magnivelaris* Peck (1.47) - described from Long Island, New York (U.S.A.), differing from *A. eburnea* by having no inflated cells in its partial veil, having few inflated cells in the universal veil at the stipe base, and having spores 8.6 - 10.9 × 5.5 - 7.8 µm (based on study of the type by Jenkins (1978));

— *Amanita elliptosperma* Atkinson (1.49) - described from North Carolina (U.S.A.), differing from *A. eburnea* by its having few inflated cells in its partial veil, having sparse inflated cells in its universal veil, and having spores 9.37 - 10.15 × 6.25 - 8.59 µm (based on study of the type by Jenkins (1982)).

Amanita magnivelaris has been reported from Mexico by Singer (1958). White species of section *Phalloideae* having globose to broadly ellipsoid spores which are also broader than those of *A. eburnea* (*A. bisporigera* Atkinson, *A. verna* (Bull. : Fr.) Roques, and *A. virosa* ss. auct. amer.) have also been reported from that country by several authors including Pérez-Silva *et al.* (1970). Pegler (1983) reports no records of any species in section *Phalloideae* in the Lesser Antilles. There is no white species of section *Phalloideae* reported for any locality in South America (Garrido & Bresinsky, 1985 and Raithelhuber, 1986).

The whitish pileus, habit, microscopic structure of the annulus and the overall average Q of the spores of *A. eburnea* are suggestive of the Mediterranean taxa *A. ovoidea* (Bull. : Fr.) Link, *A. ovoidea* var. *proxima* (Dumée) Bon & Courtecin, and *A. aminoalifatica* Filippi.[4] These entities are considered to form a closely related group in section *Amidella* (Gilbert, 1940 & 1941; Bas, 1969; Kühner & Romagnesi, 1974; Filippi, 1985). A distinguishing character of section *Amidella* is an appendiculate pileus margin which is absent in *A. eburnea.*

The collection M. H. Ivory s/244 (HONDURAS, Siguatepeque, x.1976) is believed by Dr. Ivory (pers. corresp.) to be conspecific with the collections of *A. eburnea* herein cited. Portions of Ivory s/244 were deposited in both K and DTJ. Neither portion can be located at present despite repeated searches.

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[4] An additional taxon possibly belonging to this group is known to me only from its protologue: *Amanita ovoidea* var. *ammophila* Beeli (1930: 129). The spore dimensions given by Beeli suggest a much thinner spore than is found in *A. ovoidea*: 7 - 10 × 4 - 5 µm. It appears average Q = 1.9±. No type is designated; but a collection made in September in Genck, Belgium is cited.

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LECANORA SECT. PETRASTERION (LICHENIZED ASCOMYCOTINA) IN NORTH AMERICA: LECANORA WEBERI RYAN, SP. NOV. (SUBSECT. PSEUDOCORTICATAE), FROM COLORADO

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ABSTRACT

A new crustose-squamulose lichen, **Lecanora weberi Ryan, sp. nov.**, is described from rocks in the vicinity of Boulder, Colorado. It is treated here under sect. Petrasterion subsect. Pseudocorticatae Poelt, and is probably closely related to L. novomexicana Magnusson, but is distinguished especially by its short, rather flattened and squamule-like lobes, which are grayish tinged and have a very thin upper cortex. It is also similar to forms of Rhizoplaca melanophthalma (DC.) Leuck. & Poelt sensu lato, but lacks a distinct umbilicus and lower cortex, and has adnate apothecia with orangish to yellowish brown discs and scarcely prominent margins.

This paper describes a new crustose-squamulose species of Lecanora, from Colorado. Although the new species resembles forms of both Lecanora novomexicana Magnusson sensu lato and Rhizoplaca melanophthalma (DC.) Leuck. & Poelt sensu lato, it does not fit well within either, and retains its identity when growing side by side with them. The type material has already been distributed (as "Lecanora sp. nov. Ryan") in the exsiccati series from the University of Colorado (COLO), and a diagnosis and description of the new species are given now. Until the relationship between the genera Lecanora Ach. emend. Massal. and Rhizoplaca Zopf can be clarified by further investigations, the supraspecific classification of the several apparently intermediate taxa (including L. nigromarginata Magnusson and L. opiniconensis Brodo, as well as the new species described below) is uncertain. For the present, taxa such as these, which lack a distinctly umbilicate-foliose thallus and well-developed lower cortex, appear to be best placed within Lecanora subg. Placodium (Pers. emend. Poelt) Poelt. The new species described here is treated under sect. Petrasterion subsect. Pseudocorticatae Poelt.

Unless noted otherwise, the methods and terminology used in this paper are as described by Ryan (1989a,b).

Colors (followed by numbers in parentheses), as viewed through a dissecting scope with fiber optic lighting, refer to the system of Kelly (1965). Chemical analyses were made by the standard thin-layer chromatographic (TLC) method of Culberson (1972), modified as described by Ryan (1989a).

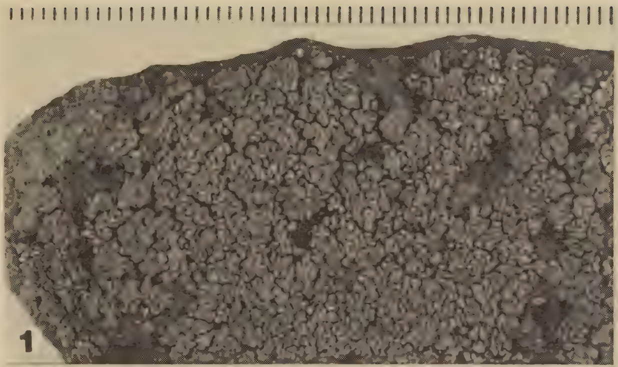
Lecanora weberi Ryan, sp. nov. (Fig. 1, 2)

In rubipus siliceis crescens, Colorado. Thallus areolatus ad squamosus, squamulis marginalibus eis centri subsimilibus vel nonnihil elongatis et lobiformibus, olivaceo-griseis, marginibus pallide flavovirescentibus instructis, non vel leviter pruinosis. Apothecia adnata ad sessilia, discis aurantiacis ad flavovirescentibus pruina flavoalbida tectis, margines leviter prominentes, continui ad crenati. Cortex superior valde tenuis, cellulas algarum emortuas includens; fasciculi hypharum subcorticales desunt vel non evoluti; cortex granulis flavescentibus inspersus; cortex inferior deest vel indistincte evolutus. Paraphyses subconglutinatae, apicibus clavatis; sporeae octonae, ellipsoidae, ca. 8-11 x 4-6 µm. Spermatia filiformia, ± curvata. Continet acidum usnicum in cortice, acida pingua (acida allo-pertusaricum, et al.) in medulla.

TYPE: U. S. A.: COLORADO: Boulder Co.: Boulder Mountain Parks, just S of city of Boulder, 1850 m, on scattered low fine-grained sandstone or quartzite boulders at base of Flatiron Mountains, in open stands of Pinus ponderosa, 10 Aug. 1986, W. Weber, COLO Exs. 685, **Holotype** (COLO!), **Isotype** (ASU!).

THALLUS areolate-squamulose, indistinctly radiating, closely appressed, not easily removed intact; areoles scattered to contiguous or weakly imbricated (fertile thalli) or becoming densely imbricated (sterile thalli); **lobes** similar to central areoles or somewhat larger and more lobe-like or squamule-like, isodiametric to moderately elongated, 1-2 mm long, 0.5-1.5 mm wide, simple or slightly branched, often strongly crenate, partly overlapping each other, flat to concave or undulate, 0.2-0.3 mm thick, appressed to slightly ascending, broadly adnate at least on side toward thallus center, often becoming free on side toward thallus margin; **thallus center** areolate-verrucose or partly areolate-squamulose in fertile thalli; areoles flat to slightly convex or undulating, with more-or-less

Figures 1-4. Lecanora weberi Ryan and similar taxa. Scale = mm. -1. Part of the holotype of L. weberi (COLO Exs. 685, COLO). -2. Part of a collection of L. weberi (Shushan and Weber S-3218, M), showing fertile thalli with verrucose areoles (upper right) and sterile thalli with imbricate squamules (below). -3. A specimen of Lecanora novomexicana Magnusson from the type locality of L. weberi (Weber, s.n., COLO). -4. Subcrustose form of Rhizoplaca melanophthalma (DC.) Leuck. & Poelt sensu lato from the type locality of L. weberi (Weber, s.n., COLO).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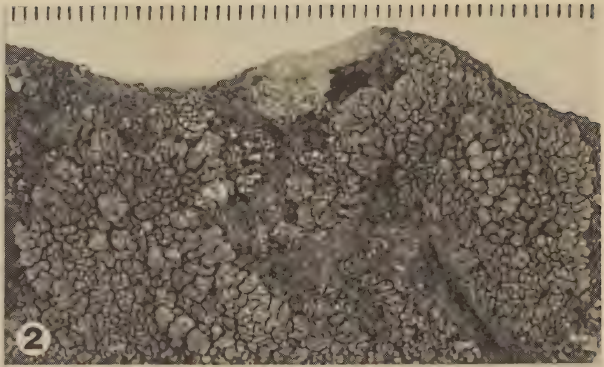
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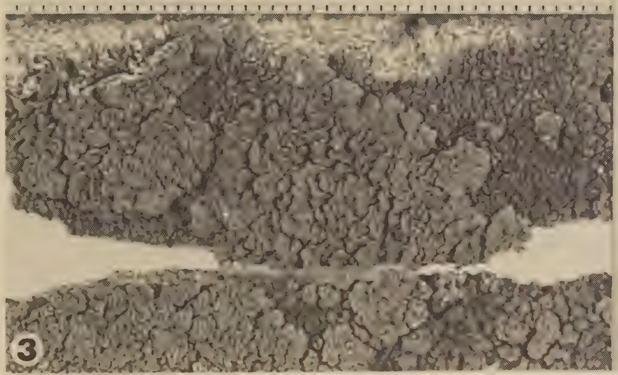
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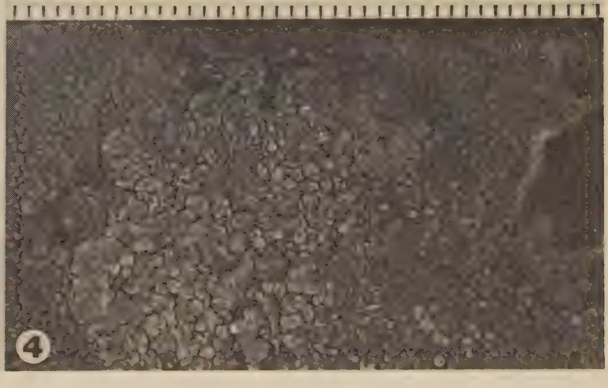
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downward-turning margins, irregular in outline, to 1(-2) mm wide, sometimes rimosely divided into secondary areoles, 0.2-0.5(1.5) mm thick, thinner toward edge, becoming crenate, usually narrowed below, broadly attached to substrate centrally or more towards one side, by about one fourth to one half the lower side, the margins often becoming free from substrate (especially in sterile thalli); **color above** in fertile thalli when fresh usually with distinctly grayish green tone, light grayish olive (109) to light olive gray (112), paler and more grayish towards thallus margin, with the squamules edges mostly pale yellowish green (121) to pale greenish yellow (104), in older herbarium specimens fertile thalli grayish yellowish green (122) to grayish greenish yellow (105), partly with orangish yellow tinges, and sterile thalli grayish yellow (90) to moderate yellow (87); **upper surface** mostly epruinose, more-or-less matt; squamule edges often somewhat roughened, with patches of whitish pruina; **color below** pale, more-or-less moderate yellowish brown (77), darker brown near attachment area; **upper cortex** with few to many dead algal cells, very thin, 5-10(-15)µm, even, without conelike hyphal bundles, mostly inspersed with fine yellowish granules (soluble in K); **algae** trebouxioid; algal layer 30-50(-75) µm thick, continuous to interrupted; **medulla** moderately loose, partly filled with clumps of gray granules; hyphae 3-5 µm diam.; **lower cortex** absent, or (on ascending squamules) 12-15 µm thick, often poorly developed, broken and penetrated by medullary hyphae; hyphae ca. 5 µm diam., lumina 2 µm.

APOTHECIA usually numerous and becoming crowded (but sometimes absent or rare), to three per areole, 1-1.3 mm diam., borne submarginally to laminally on the squamules, adnate to broadly sessile; **disc** often slightly concave when young, becoming plane to undulate when old, usually densely whitish-yellowish pruinose, but often epruinose when young, grayish yellow (90) to yellowish gray (93) or sometimes almost pale greenish yellow (104) with pruina, light to deep orange (51-52) to moderate yellowish brown (77) under pruina, often darker and more olivaceous when young; **margin** about 0.1-0.2 mm thick, soon irregularly with irregularly foveolate surface, entire or somewhat crenate, becoming flexuous or distorted in age, sometimes distinct and more-or-less raised from the start, persistent, often somewhat paler than thallus and weakly pruinose; **hymenium** hyaline, 50-65 µm high; epihymenium brownish, weakly inspersed with fine granules (partly soluble in K) and covered by 15-20 µm thick superficial layer of coarse granules (soluble in K); **paraphyses** distinct and more-or-less free in water, about 1.5-2 µm thick below, the tips 2-2.5 µm thick, colorless; **subhymenium** grayish, with oil droplets; **excipulum** hyphae gelatinized but somewhat distinct in water, densely packed, irregularly oriented, ca. 3-5(-7) µm diam., the lumina more-or-less short, 1 µm wide; **parathecium** hyphae parallel; **hypothecium** distinct from subhymenium, hyaline to slightly yellowish-brownish, to 300 µm thick in center; **amphithecium** similar in structure to thallus but **cortex** to 30-50 µm thick in lower part; algal layer about 50 µm thick below hypothecium, continuous to interrupted; algae filling most of the margin; **asci** 35-40 x 10-12 µm, Lecanora-type; **spores** ellipsoid to oblong-ellipsoid (L:W = 1.8-2.4:1), about 8-11(-13) x (3-)4-6(-7) µm, with one or two oil droplets, 8 per ascus, the wall about 0.5 µm thick.

SPERMOGONIA immersed, the ostiole pale, the cavity ca. 100-150 um diam.; **spermatia** curved, (15-)20-25 µm long.

SPOT TESTS AND CHEMISTRY: Thallus and apothecia C-, Pd-; **cortex** K- or + yellowish; KC+ yellowish; with usnic acid (often only traces); **medulla** K-, KC-, I_2KI-; with fatty acids of the protolichesterinic group (allo-pertusaric and dihydropertusaric, constipatic, protoconstipatic and dehydroconstipatic acids), and sometimes traces of unknowns; **discs** K-, KC-. A specimen was analyzed by C. Leuckert (Shushan & Weber S-3218, COLO).

DISTRIBUTION AND ECOLOGY: Montane areas of western U. S. A. (Colorado, to Idaho and S. Dakota), on siliceous rocks (sandstone, conglomerate, quartzite, arkosite), usually in moderately shaded areas, on horizontal to sloping faces near tops of boulders or outcrops, in open forest, sometimes in canyons, 1050-1875 m; often very abundant, covering whole level surfaces of boulders; **associated organisms** include the vascular plants Pinus ponderosa or P. edulis, or Cercocarpus montanus, and the lichens Lecanora muralis, L. novomexicana, L. sp. (L. polytropa group?), Rhizoplaca melanophthalma sensu lato R. chrysoleuca sensu lato ("R. subdiscrepans" morphotype), Acarospora fuscata, Aspicilia caesiocinerea, Candelariella spp., Dimelaena oreina, Lecidea atrobrunnea, Melanelia spp., and Xanthoparmelia spp.

OTHER REPRESENTATIVE SPECIMENS EXAMINED: U. S. A. COLORADO: Boulder Co.: near Boulder, Shushan & Weber S-3218 (COLO, M, WIS); near Lyons, Weber L-72985 (COLO); **Garfield Co.:** 7 km N of Rifle, Ryan 20678 (ASU); **Larimer Co.:** km SW of Ft. Collins, Anderson S-20272 (COLO); **Moffat Co.:** 25.5 km N of Axial, Ryan 20637 (ASU). **IDAHO: Bonneville Co.:** Palisades Reservoir, Ryan 19590 (ASU). **SOUTH DAKOTA: Pennington Co.:** 6.5 km NW of Hermosa, Wetmore 10285 (MIN, UPS).

DISCUSSION: The new species is named after the collector of the type material, William Weber of the University of Colorado at Boulder, in honor of his work on lobate species of Lecanora in North America.

The two taxa with which L. weberi is most likely to be confused are L. novomexicana sensu lato and Rhizoplaca melanophthalma sensu lato (Figs. 3 and 4, respectively). All three taxa have pruinose apothecia and an upper cortex containing dead algal cells, and contain usnic acid and fatty acids of the pertusaric/constipatic group. At the type locality of L. weberi and other locations, the three taxa grow side by side, yet each remains distinct, with a different overall appearance produced by a combination of features. Lecanora weberi differs from the other two species especially by its very thin cortex and lack of psoromic acid, and by its more grayish, pale-edged, frequently imbricated squamule-like lobes. Its marginal lobes are shorter, flatter and more loosely attached than those of L. novomexicana. Lecanora weberi differs from R. melanophthalma in that the new species lacks a distinct umbilicus and lower cortex and has apothecia that are adnate, with orangish to yellowish brown discs and scarcely prominent margins. Many of the characteristics of L. novomexicana and R. melanophthalma (e.g., chemistry, growth form, and colors of the thallus and apothecia) that are useful for distinguishing those species from L. weberi at the type locality of the latter do not apply at other localities. Especially in the case of R. melanophthalma, the material from the type locality of L. weberi is not very typical. In fact, both of these other species (as presently delimited by most authors) are extremely variable and plastic, can also be very difficult to distinguish from each other, and may well consist of several taxa.

The morphology and color of the thallus of L. weberi itself are also somewhat variable. Especially interesting is the difference between the more common, predominantly fertile forms (areolate-verrucose thallus center, squamulose-lobed margin) and the occasional, mostly sterile forms (more-or-less imbricate squamulose throughout) that occur on or next to the parent thalli. The origin of such dimorphism, which also occurs in various other lobate taxa, is unknown.

ACKNOWLEDGEMENTS

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TWO NEW SPECIES OF THE GENUS ASCOCHYTA LIB.

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ABSTRACT. Two new species of genus Ascochyta Lib. - A.urticicola Vanev et Bakalova, sp.nov. and A.digitalina Vanev et Bakalova, sp.nov., from Bulgaria, are described and illustrated.

During inventory investigations of genus Ascochyta Lib. (order Sphaeropsidales, class Deuteromycetes) in Bulgaria, two new species belonging to this genus were established.

ASCOCHYTA URTICICOLA Vanev et Bakalova sp.nov.

Maculae 0,1-0,8 cm in diam., orbiculares vel angulatae, solitariae interdum comfluentes, atro-brunneae vel nigrae, saepe concentric zonatae. Pycnides epiphyllae, sparsae, solitariae, globosae vel depresso-globosae, pallide brunneae, 110-180µm in diam., poro orbiculari 25-35µm in diam., cellulis parvis obscurioribus cincto. Conidia cylindrica vel elliptica utrinque rotundata, uni-vel biseptata, saepe ad septum leniter constricta, hyalina, (10) 13,5-17,5(21) x 4-5(6)µm (Fig. 1A).

In foliis Urticae dioicae L., Bulgaria, mons Pirin, Predela, 26.09.1975, S.G.Vanev, G.G.Bakalova, SOM 18962 M, holotypus.

Leaf spots 0,1-0,8 cm in diam., numerous, rounded or angular, single or often confluent, dark brown or black, more pale in the centre, occasionally concentric. Pycnidia spheric or flattened, single, scattered, pale-brown, 110-180µm with circular ostiol, 25-35µm in diam., surrounded by zone of darker cells. Conidia cylindric with rounded both ends or ellipsoidal, straight or slightly curved, hyaline, 1-2(rarely 3)septate, occasionaly constricted at the septa, (10)13,5-17 x 4-5(6) μm .

Specimen examined: on living leaves of *Urtica dioica* L., Bulgaria, Pirin mount., Predela, 26.09.1975, S.G. Vanev and G.G.Bakalova, SOM 18962 M (holotype).

There is only one *Ascochyta* species registered on plants belonging to genus *Urtica*- *A.urticae* A.L.Sm.et Ramsb.

Melnik(1977) delimited 2 subgenera of *Ascochyta* on the basis of the number and disposition of conidial septa. According to this author *A.urticae* belongs to subgenus *Libertia* Melnik since the conidia have only 1 central septum dividing the conidium into 2 nearly equal cells.

Ascochyta urticicola clearly differs from *A.urticae* in the size of conidia and the number of the conidial septa, 1 or 2, rarely 3 (Table 1).

Table 1.
Comparative morphologic data of *Ascochyta urticicola* and *A.urticae*

Subgenus	Species	Dimensions of conidia in μm		Number of septa in conidia
		lenght	width	
Ascochyta	A.urticicola	(10)13,5-17,5(21)	4-5(6)	1-2(3)
Libertia	A.urticae (by Melnik,1977)	7-12	2-4	1

For this reason it is necessary to place *A.urticicola* in subgenus *Ascochyta* Melnik.

There are 2 other *Ascochyta* species parasitic on plants of the same family (Urticaceae)- *A.parietariae*

Roum.et Fautr.(on *Parietaria officinalis* L.) and A.*boehmeriae* Woronichin (on *Boehmeria* ssp.) but they differ from *A.urticicola* not only in the host-plants but morphologically also.

ASCOCHYTA DIGITALINA Vanev et Bakalova, sp.nov.

Maculae 0,3-1,5 cm in diam., orbiculares, solitariae, globosae vel confluentes, ochraceae vel pallide brunneae, indistincte atropurpureo-marginatae. Pycnides epiphyllae sparsae, solitariae, globosae vel depresso-globosae, pallide brunneae immersae, 110-175µm in diam. poro orbiculari 20-35µm in diam., cellulis atrofuscis cincto. Conidia cylindrica utrinque rotundata, interdum oblongo-elliptica vel clavata, recta vel leniter curvata, distincte uni-vel biseptata, ad septum haud vel vix constricta interdum inaequaliter bicellulata, hyalina, (12,5)15-17,5 x (4)4,5-5(6)µm (Fig. 1B).

In foliis vivis *Digitalidis viridiflorae* Lindr., Bulgaria, mons Rodopi, Beglica, 2.08.1981, S.G.Vanev, SOM 18964 M, holotypus.

Leaf spots 0,3-1,5 cm in diam. rounded, single or confluent, ochraceous or palebrown with dark- brown or dark-violaceous wide border. Pycnidia more or less spheric, separate, scattered thin-walled, pale-brown, 110-175µm in diam., with a single, circular ostiol 20-35µm in diam., surrounded by darker cells. Conidia cylindric with rounded both ends, or ellipsoidal, rarely clavate, straight or slightly curved, hyaline, 1-2-septate, occasionally constricted at the septa (sometimes with 2 unequal cells), (12,5 15-17,5 x (4)4,5-5(6)µm .

Specimen examined: on living leaves of *Digitalis viridiflora* Lindr., Bulgaria, Rodopi mount., Beglica, 2.08.1981, S.G.Vanev, SOM 18964 M, (holotype).

Two different *Ascochyta* species parasitic on plants of the genus *Digitalis* are described in the literature- *A.digitalis* Fuckel and *A.moelleriana* Wint. Melnik (1977) has studied the type specimens of both species and has rejected *A.digitalis* as a misdetermined species. According to this author A.moelleriana is a later synonym of A.euphrasiae Oud. He has placed A.euphrasiae in subgenus Libertia because of the 1-septate conidia.

The new species A.digitalina belongs to subgenus Ascochyta and clearly differs from A.euphrasiae in size of conidia and the number and disposition of the septa (Table 2).

Table 2.
Comparative morphologic data of Ascochyta digitalina and A.euphrasiae

Subgenus	Species	Dimensions of conidia in μm		Number of septa in conidia
		lenght	width	
Ascochyta	A.digitalina	(12,5)15-17,5(20)	(4)4,5-5(6)	1-2
Libertia	A.euphrasiae (Melnik,1977)	7-12	3-4	0-1

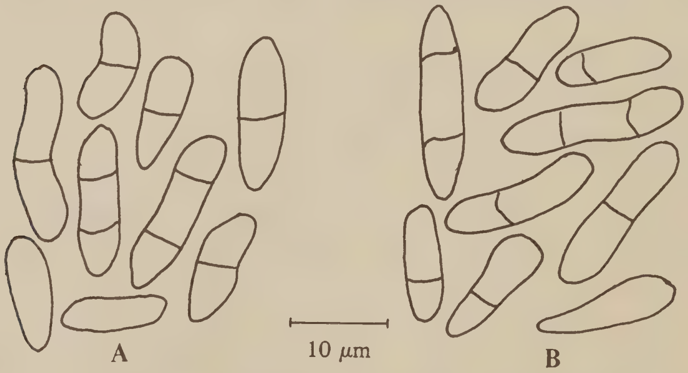

Fig.1 Conidia of: A. Ascochyta urticicola
B. A. digitalina

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TYPE STUDIES IN MARASMIOID AND COLLYBIOID FUNGI (TRICHOLOMATACEAE)
II. AGARICUS GRAMINUM

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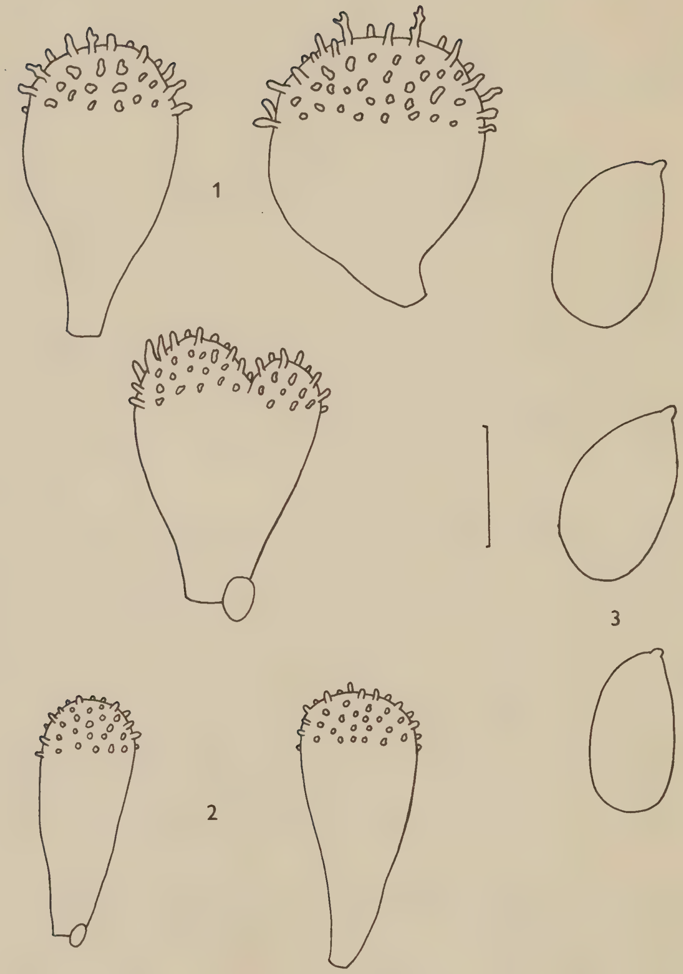
ABSTRACT

The results of the revision of the type specimens of *Agaricus graminum* Libert /= *Marasmius graminum* (Libert)Berk. et Br./ are published. *Agaricus graminum* in the original sense of Libert differs from *Marasmius graminum* in sense of contemporary authors. It is proposed to use the name *Marasmius curreyi* Berk. et Br. for the latter.

During preparation of a monograph of Central-European species of the genus Marasmius and type studies in these fungi, I was very surprised to find that the type specimen of *Agaricus graminum* Libert distributed in the collection of exsiccata "Plantae Cryptogamae Arduennae" differs from *Marasmius graminum* in sense of contemporary authors. I have found the same fungus in the Favre´s herbarium in Geneve, which was published by Favre (1960) as a bisporic form of *M. graminum*. *Marasmius graminum* in the sense of contemporary authors is a cosmopolite species and all modern mycologists have this taxon in the same conception. Therefore, this fact mentioned above is very interesting. In the present paper, I give the descriptions of both species and also the reasons for a proposal to select as correct name *Marasmius curreyi* Berk. et Br. for the distinguished second species.

Marasmius graminum (Libert) Berkeley et Broome
Agaricus graminum Libert, Pl. Crypt. Arduennae, Fasc. II, No. 119, 1832.
Marasmius graminum (Libert) Berk. et Br., Outl. Brit. Fung., London, p. 222, 1860.

Macrofeatures (partly according to Favre´s notes and partly from the type-specimens): PILEUS up to 4.5 mm broad but usually smaller, convex, opaque, with or without papilla, plicate, red-brown with the darker centre. LAMELLAE distant, L = (4-)6-8, l = 0, collariate, collarium very fine but prominent, not pure white but cream-whitish. STEM up to 25 mm long, filiform, smooth, lustrous, whitish above, black-brown to almost black below.



Figs. 1-3. Marasmius graminum (type-specimen): 1. Pileipellis. 2. Cheilocystidia. 3. Basidiospores. Scale bar = 10 µm.

Microfeatures (figs. 1-3): BASIDIOSPORES ellipsoid, broadly ellipsoid to slightly amygdaliform, indextrinoid, hyaline, thin-walled, smooth, of two sizes: 7-12 x 2.5-4 µm and (9-)11-16(-18) x (5-)6.2-8(-10) µm; the second one is more common. BASIDIA clavate, clamped, 2- and 4-spored, e.g. 24 x 8 µm. BASIDIOLES clavate, broadly clavate, fusiform, sometimes with a broad and obtuse top, thin-walled, clamped, 13-29(-32) x (4.5-)6-10(-11) µm. CHEILOCYSTIDIA of the similar form as the broom cells of the pileus surface, clamped, thin-walled, 16-27 x (5-)6-10 µm, projections up to 2-4(-5) µm long. PLEUROCYSTIDIA none. SUBHYMENIUM of thin-walled, branched, cylindric, slightly dextrinoid hyphae, 2-4 µm broad. TRAMA of the lamellae of cylindric, thin-walled, dextrinoid, less branched, clamped, 3-8 um broad hyphae; flesh of the pileus of interwoven, thin-walled, clamped, more or less cylindric, branched, slightly dextrinoid hyphae, sometimes finely incrusted, 2.2-9 µm broad; flesh of the stem in cortex of parallel, slightly dextrinoid, cylindric, clamped, slightly thick-walled (up to 0.8-1.2 µm), 3-4 µm broad hyphae, on the surface smooth, in medulla of parallel, dextrinoid, cylindric, thin-walled (up to 0.5 µm), clamped, 2-8 µm broad hyphae. PILEIPELLIS hymeniform, of cylindric-clavate, clavate, broadly clavate to almost globose cells, clamped, thin-walled, 13-28 x 8-24 µm, with irregular, simple to corraloid branched projections above, 1-3(-6) µm long, these broom cells mostly of the Rotalis-type but sometimes of a type transient to Siccus-type, the upper part of broom cells and the projections brown pigmented; between these cells are sometimes almost smooth to smooth cells and rare thin-walled hyphae with 4-6 µm long projections.

Material revised:
BELGIUM: Pl. Crypt. Arduennae, Fasc. II., No. 119, Libert, 1832, PRM 707065 (Lectotype), BPI, BP 18185, BR, K (ut Agaricus graminum).
SUISSE: Entre le God Trid et le God Purcher, vers 1900 m, val Trupschun pr. S-chauf, Hm Engadine, dans une aunaie sur graminées pourissantes, 9.IX.1955, J.Favre, G 14465 (ut Marasmius graminum forme bisporique).

This species is characterized macroscopically especially by the low number of lamellae and microscopically by the size of spores, character of broom cells of the pileus epicutis and especially of their projections.

The type-specimens from Libert´s collection "Plantae Cryptogamae Arduennae" are preserved in many herbaria. The specimen from BPI was designated as an "isotype" (Gilliam, 1976). However, all the specimens of these exsiccata must be considered syntypes. The "isotype" (BPI) consists of two parts of the stem, with the absence of pileus, and thus this specimen has not any significance as a type. I revised these type-specimens from 5 important herbaria (BP, BPI, BR, K, PRM); the best specimen of them was that from the herbarium of the National Museum in Prague. Therefore, I propose it (PRM 707065) as a lectotype. However, the best revised material of this species was the Favre´s collection from Suisse (G 14465)

The oldest synonym for *Marasmius graminum* treated in various papers and monographs of marasmioid fungi is *Marasmius pruinatus* Berk. et Curt. 1859 (not *M. pruinatus* Rea 1916). In monographs of Singer (1958, 1965, 1976), this name is mentioned as a synonym while Gilliam (1976) after the type study of the holotype-specimen (K) and authentic material of Berkeley et Curtis (FH) considers *Marasmius pruinatus* an independent species. According to this author, this species differs from *M. graminum* especially by the finely divided projections on the cuticular cells of *M. pruinatus* which contrast with the broader, discrete projections of *M. graminum*.

I have revised the specimen of *M. pruinatus* from Farlow Herbarium and my results agree with Gilliam´s solution. The microfeatures were the following (figs. 4-5): BASIDIOSPORES clavate to drop-shaped, indextrinoid, hyaline, thin-walled, smooth, 10.1-14.2 x 3.2-4.2 µm. BASIDIA clavate, 4-spored, clamped, 21-24 x 6.2-7.7 µm. BASIDIOLES clavate, fusiform, clamped, often with prominent obtuse top, thin-walled, 14-26 x 4.7-8 µm. CHEILOCYSTIDIA of the similar form as the broom cells of the pileus epicutis, clavate, with more or less nodulose projections, thin-walled, e.g. 16 x 7.5-8 µm. PLEUROCYSTIDIA none. SUBHYMENIUM of dextrinoid, thin-walled, clamped, 2-3.5 µm broad, hyaline hyphae. TRAMA of the lamellae of dextrinoid, clamped, thin-walled, sometimes branched, 2.5-7 µm broad hyphae; flesh of the pileus of dextrinoid, thin-walled, branched, clamped, hyaline,3-6 µm broad hyphae; flesh of the stipe of parallel, clamped, dextrinoid, 3-7 µm broad, thin-walled (in medulla) and thick-walled (up to 1-1.5 µm in cortex) hyphae; surface of the stipe smooth. PILEIPELLIS hymeniform, of broom cells of the Siccus-type, cells clavate, sometimes clamped, thin-walled to thick-walled in the upper part, with up to 5.5 µm long, more or less nodulose, obtuse projections, 9-14 x 5.2-8 µm; some cells coralloid branched with some thick-walled projections.

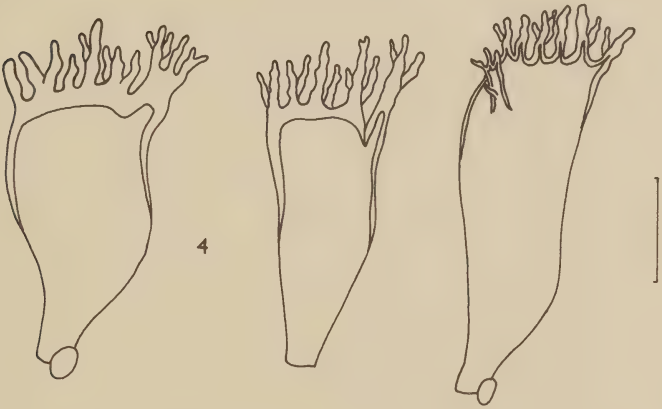
These microfeatures show unambiguously that this species belongs to the section Sicci. These results agree with conclusions of D.E.Desjardin on the revision label dated 3.II. 1988 and 10.III.1989.

Therefore, I have studied the type-specimen of the second older known synonym - *Marasmius curreyi* Berk. et Br. 1879. In my opinion, features of this specimen as well as Cooke´s table 1130B (Cooke, 1890), agree well with descriptions of the common "*M. graminum*" in the sense of contemporary authors and both taxa are conspecific. According to Dennis (1951), *Marasmius exustus* Berk. et Curt. 1879 could be identical with "*M. graminum*", too. The type-specimen is preserved in FH (not in K). However, according to Singer (1976) who revised this type, *M. exustus* represents a species from the section Hygrometrici. Therefore, I propose to use the name *Marasmius curreyi* as the correct one for the species called "*M. graminum*" now. A full description of this species follows now.

Marasmius curreyi Berkeley et Broome, Ann. Mag. Nat. Hist. V, 3:209, 1879.

Marasmius graminum (Libert) Berk. et Br. ss. auct., e.g. Gilliam (1976), Singer (1976).
Marasmius tritici Young, Phytopathology, 25:116, 1925.

Macrofeatures: PILEUS 4-6 mm broad, conical-hemispherical, then convex to expanded, sometimes with slightly revolute margin, with a small papilla, especially when young, then often with small umbilicus, smooth, under lens slightly tomentose, slightly plicate, young red-brown to rusty-brown to pinkish-brown. LAMELLAE distant, L = 9-13, l = 0, collariate, very rarely without distinct collarium, with concolorous edge, white. STEM 18-26 mm long, filiform, lustrous, smooth, whitish to white above, through brown to dark red-brown to black-brown toward the base.



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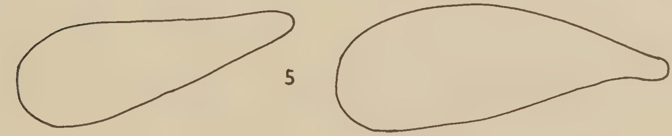

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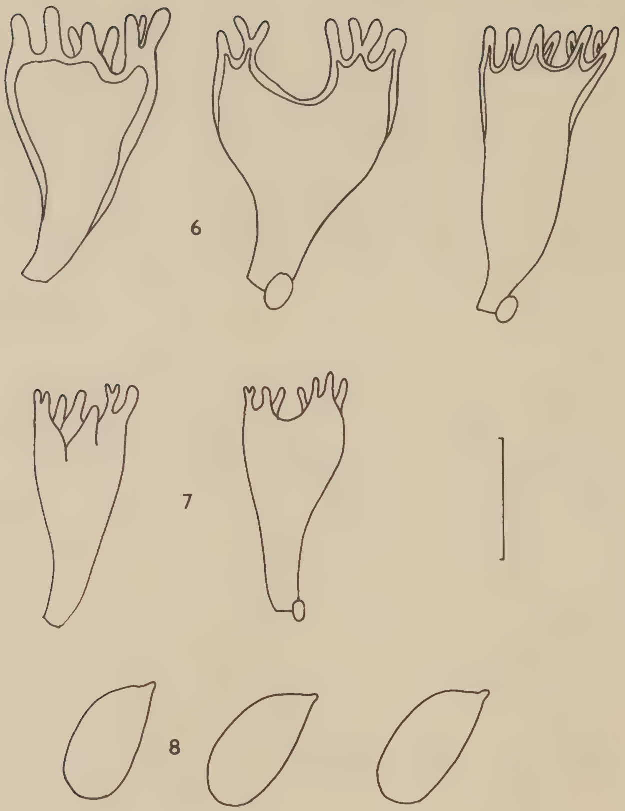
Figs. 4-5. *Marasmius pruinatus* (authentic material): 4. Pileipellis. 5. Basidiospores. Scale bar = 5 µm.



Figs. 6-8. Marasmius curreyi: 6. Pileipellis. 7. Cheilocystidia. 8. Basidiospores. Scale bar = 10 µm.

Microfeatures (figs. 6-8): BASIDIOSPORES ellipsoid, cylindric-ellipsoid to slightly amygdaliform, smooth, thin-walled, hyaline, (7.7-)8-11(-13) x 4-5.7(-6.5) µm. BASIDIA clavate, clamped, 4- rarely 2-spored, 15-30 x 4-7 µm. BASIDIOLES clavate, cylindric-clavate, slightly fusiform, clamped, 18-28 x 4-8 µm. CHEILOCYSTIDIA of the similar form as the broom cells of the pileipellis, more or less clavate, hyaline, 10-16(-20) x 6-12 µm, with 1-7(-8) µm long, hyaline to slightly yellowish projections above. PLEUROCYSTIDIA none. SUBHYMENIUM of thin-walled, cylindric, clamped, branched, hyaline, 2-4 um broad hyphae. TRAMA of the lamellae of dextrinoid, thin-walled, clamped, hyaline, 3-8 um broad hyphae; flesh of the pileus of dextrinoid, branched, interwoven, thin-walled, clamped, hyaline, 3-7(-10) um broad hyphae; flesh of the stem in cortex of parallel, clamped, slightly thick-walled (up to 1 µm), yellow-brown to brown pigmented, in medulla dextrinoid, parallel, thin-walled, clamped, hyaline, 2.2-8 µm broad hyphae. PILEIPELLIS hymeniform, of broom cells of the Siccus-type, clavate or short cylindric-clavate, some of them thin-walled and hyaline, other (usually a great part of them) slightly thick-walled above, 9-22 x (6-) 8-14(-18) µm, with 2-5(-7) µm long, obtuse projections, cells hyaline below, yellow-brown obove and in the projections.

Habitat: on remnants of Poaceae, Juncaceae, Cyperaceae and rarely of some other plants.

Material revised:
BELGIUM: Westerloo (prov. Antwerpen), 1941, Tuymans (BR). - Bruxelles (Brabant), 1891, Delogne (BR).
CZECHOSLOVAKIA: Dolany near Unhošť, 1939, Herink (PRM 139045) - Řepy near Praha, 1952, Pouzar (PRM 707068). - Praha-Žižkov, 1968, Svrček (PRM 671895). - Praha, Kinského sady, 1963, Wichanský (PRM 600982 and 624000). - Praha, Stromovka, 1952, Pouzar (PRM 707057); 1948, Vacek (PRM 707075). - Mnichovice, 1918, Velenovský (PRC and PRM 707061). - Mnichovice, Myšlín, 1939, Velenovský (PRM 153986). - Mnichovice, Hubačov, 1939, Velenovský (PRM 154305). - Libochovičky, 1916, Velenovský (PRC and PRM 707062). - Kročehlavy near Kladno, 1941, Herink (PRM 707064). - Černolice near Dobřichovice, 1950, Pouzar (PRM 707069). - Mořinka near Dobřichovice, 1947, Svrček (PRM 707080). - Pyskočely near Stříbrná Skalice, 1951, Pouzar (PRM 707059, 707067, 707070, 707071). - Ruda near Nové Strašecí, 1939, Herink (PRM 139124). - Poříčko, 1950, Pouzar (PRM 707072). - Kosoř, 1950, Vacek (PRM 707073). - Libřice, 1941, Herink (PRM 707060). - Karlštejn, 1946, Vacek (PRM 707081); Svrček (PRM 707078). - Drahelčice, 1947, Vacek (PRM 514995). - Horní Slavěnice near Lomnice n. Luž., 1962, Svrček (PRM 567936). - Smržov near Lomnice n. Luž., 1961, Kubička (PRM 616353); 1962, Svrček (PRM 567935). - Hamr-Kosky, 1980, Kubička (CB 2344). - Záboří near Blatná, Skalický (PRC). - Lutová near Třeboň, 1945, Svrček (PRM 707126). - Třeboň, 1979, Kubičková et Kubička (CB 2161). - Vodňany, 1937, 1938 and 1943, Herink (PRM 490571, 490566, 499642 and 707077). - Čimelice near Písek, 1961, Svrček (PRM 616352). - Laziště near Písek, 1963, Svrček (PRM 612757). - Vrábsko near Čimelice, 1966, Svrček (PRM 626072 and 626073); 1963, Pouzar (PRM 612756). - Zvíkovské Povltaví, 1954, Pouzar (PRM 617489). - Golčův Jeníkov, 1940, Herink (PRM 707063 and 707066). - Nemyšl near Tábor, 1943, Svrček (PRM 707058). - Vidnava (Weidenau), 1912 and 1919, Hruby (BRNM 07311/39 and 07310/39). - Bojkovice-Bzová, 1985, Antonín (BRNM). - Kuřim, 1942, Šmarda (BRNM 313942). - Zdravá Voda near Žarošice, 1947, Vacek

(PRM 707076). - Prenčov, 1898 and 1901, Kmeť (BRA). - Turčianský Martin, 1951, Šmarda (BRNM 313941). - Rača, 1951, Krippelová et Šmarda (BRA). - Zemianské Podhradie (Ns.Podhragy), 1884, Bäumler (BP 19704).
ENGLAND: on Rye, Cooke (K). - Kew, Royal Bot. Gardens, 1966 (K). - Coughton (Warwicks), Clark (K). - Canseway, Slapton (Dorset), 1981, Clark (K). - Arington Court (N.Devon), 1978, Clark (K). - West Nolesey (Surrey), 1979, Spooner (K). - Hale Barnes Playing Fields (Cheshire), 1980, Newton (K). - Kew, 1912 (K). - Arbrook Common, Esher (Surrey), 1981, Spooner (K). - Holm Fen (Huntongdonshire), 1965, Houtton (K). - Cranbourne Park, Windsor Park (Berkshire), 1967, Dennis and Reid (K). - Lickey Hills (Worcestershire), 1968, Price (K). - Maidenhead (Berkshire), 1970, Verdcourt (K).
FIJI: Viti Levu, Savura Creek, 1976, Maddison and Kirby (K).
FRANCE: Santes, Courtecuisse (Herb. Courtecuisse).
GERMAN DEMOCRATIC REPUBLIC: Dienstädt (Ostthüringen), 1975, Hirsch (JE B 591/50). - Halle/Saale, Dölauer Heide (Sachsen-Anhalt), 1974, Hirsch and Braun (JE B 475/42). - Halle-Neustadt (Sachsen-Anhalt, 1971, Hirsch (JE B 48/4). - Bräunsdorf (Sachsen), 1970, Zschieschang and Ebert (JE). - Dübener Heide (Sachsen-Anhalt), 1977, Dörfelt (HAL); 1970, Hirsch (JE B 74/4). - Eisleben (Sachsen-Anhalt), 1972, Hirsch (JE B 201/15).
HUNGARY: Tiszacsege, Hortobagy (Hajdu-Bihar), 1974, Babos (BP 51592). - Tahi, Mts. Pilis, 1955, Bohus and Babos (BP 30833). - Csúcshégy, Mts. Budai, 1957, Bohus and Babos (BP 39251). - Tökhegy, Mts. Budai, 1954, Bohus and Babos (BP 39250).
THE NETHERLANDS: Osgstgeest (Zuid-Holland), 1955, Bas (BRNM 96794 and K).
POLAND: Wroclaw (Breslau), Schroeter (BRA).
ROMANIA: Cluj, 1959,Silaghi (PRM 533819).
SWEDEN: Göteborg, Stora "Änggården" (Västergötland), 1937, Nathorst-Windahl (PRM 103546 and K).
WEST PAKISTAN: Lahore and Sialkot, 1959, Sultan Ahmad (K).

Marasmius curreyi differs from the above mentioned M. graminum ss.str. especially by the broom cells of the pileipellis solely of the Siccus-type and the smaller, rather ellipsoid to cylindric-ellipsoid spores. The number of the lamellae is usually lower in the first species.

According to these results, seven species of Marasmius section Marasmius occur in Europe - Marasmius alniphilus Favre, M. bulliardii Quél., M. curreyi Berk. et Br., M. graminum (Libert) Berk. et Br., M. limosus Quél., M. rotula (Scop.: Fr.) Fr. and M. wettsteinii Sacc. et Syd.

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VACCINIUM FUNGI: HELICOMA VACCINII SP. NOV.

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An apparently undescribed species of *Helicoma* Corda was found on *Vaccinium elliotii* Chapman stems during a survey of fungi on *Vaccinium* spp. in the eastern U.S. The fungus is described as a new species and illustrated from culture and host tissue. It represents the first report of a *Helicoma* from *Vaccinium.*

The *Helicoma* sp. was colonizing a vertical scar on a stem section of *V. elliotii* collected near the Satilla River, Ware Co., Georgia. Conidia were streaked onto Difco Bacto-Agar and single germinating conidia transferred to the following types of media: Difco malt extract agar (MEA), Difco corn meal agar (CMA), full and half-strength Difco potato dextrose agar (PDA) and V8 agar (Stevens, 1974). Cultures were maintained under laboratory bench conditions of fluctuating light and temperature (18-20 C).

Helicoma vaccinii L. M. Carris sp. nov. Figs. 1-13.

Coloniae in agaro cum Zeae farina composito cultae aetate quinque hebdomadum diametrum 0.6-1.0 cm attingentes; mycelio atro-brunneo, lanato vel caespitoso. Coloniae in caulibus effusae, hirsutae, atro-brunneae. Mycelium immersum vel superficiale, ex hyphis septatis, brunneis, 1.7-3.4 μm crassis. Conidiophora plerumque simplicia vel raro ramosa, flexuosa, atro-brunnea, cellulis apicalibus pallide brunneis, interdum rugosa, 4-10 septata, 64-145 μm long., 4.2-5.0 μm lat. ad basim, 2.5-3.3 μm lat. ad apicem, proliferationibus percurrentibus pluribus (1-3). Cellulae conidiogenae mono- vel polyblasticae, denticulatae; denticula 1.3-2.7 μm long., 1.0-1.3 μm lat. Filamenta conidica in 1.5-1.75 spiris convoluta, 4-8 septata, apice rotundato, basi truncata, 2.0-4.0 μm crassa. Conidia hyalina vel pallide brunnea, laevia, 8.0-13.0 μm lata.

Habitat in caulibus *Vaccinii elliotii*, Satilla River, Ware Co., Georgia. N. Vorsa, 9.vii.1988 (herb. BPI) HOLOTYPUS.

Five-wk-old colonies on CMA 0.6-1.0 cm diam, dark brown, woolly to floccose, sporulation abundant, border even, slightly crenate, reverse dark brown. Colonies on stem effuse, hairy, dark brown. Mycelium immersed and superficial, hyphae septate, brown, 1.7-3.4 μm diam. Conidiophores (Figs. 1B, 1E, 3, 9) simple or rarely branched, cylindrical, flexuous, dark brown with pale apical cells, occasionally roughened, 4-10 septate, 64-145 μm long, 4.2-5.0 μm wide at base, 2.5-3.3 μm wide at apex, usually with 1-2 percurrent proliferations (Fig. 6). Conidiogenous cells (Figs. 4, 5) mono- or polyblastic, denticulate, denticles 1.3-2.7 μm in length, 1.0-1.3 μm wide. Conidial filament coiled 1.5-1.75 times, 4-8 septate, rounded at apex and tapering to a truncate base, 2.0-4.0 μm diam. Conidia (Figs. 1E, 1D, 7, 8, 10, 11) hyaline to pale brown, smooth, 8.0-13.0 μm diam.

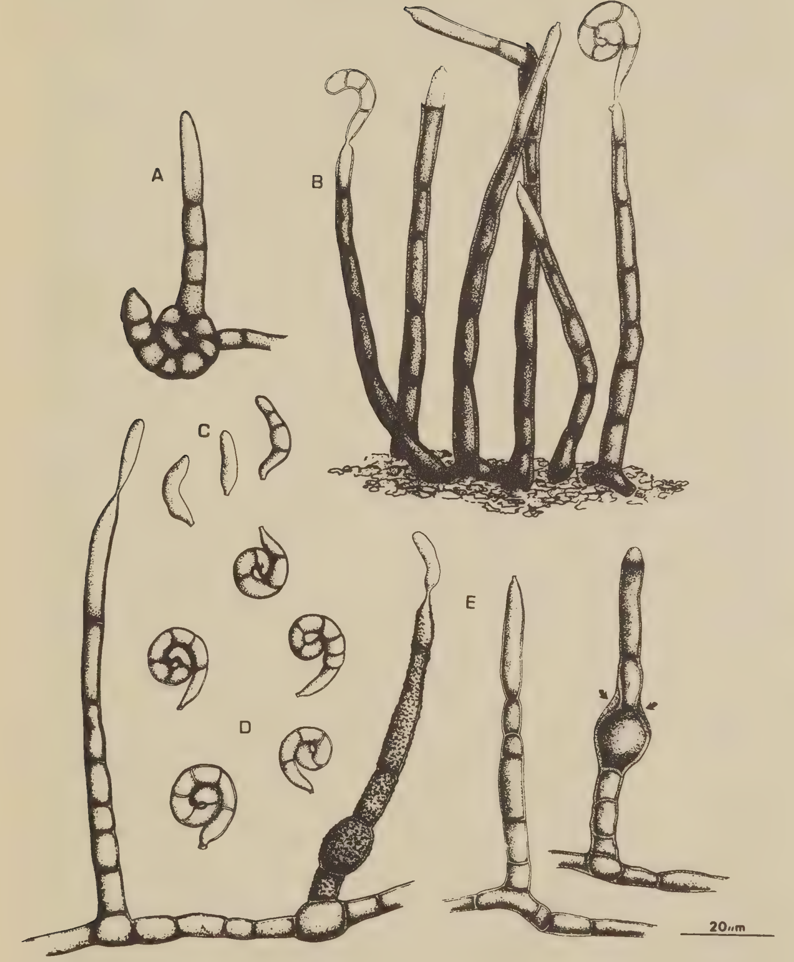
HABITAT: On stem scars of *Vaccinium elliotii*.
DISTRIBUTION: Ware Co., Georgia, U. S. A.

MATERIAL EXAMINED: LMC 0043, HOLOTYPE, deposited as stem section, dried culture, and prepared slides in BPI. ISOTYPE specimen deposited at WSP, living culture deposited as ATCC 66068.

OTHER PERTINENT MATERIAL EXAMINED: *Helicoma muelleri* Corda, IMI 78575, FH-Linder No. 1341; *Tubeufia pezizula* (Berk. & Curt.) Barr (*H. muelleri* anamorph), IMI 73306; *H. ambiens* Morgan, FH-co-type.

Only minor differences were noted between colonies on host tissue (Fig. 2) and in culture. Conidiophores formed in culture frequently had roughened walls and enlarged cells with a dark, vesicle-like outer wall layer (Fig. 1E) that were not evident in colonies on host material.

Fig. 1. *Helicoma vaccinii*. A. Conidiophore developing from cell of conidium in culture on CMA. B. Conidiophores on *Vaccinium elliotii*. Note proliferations. C. Immature conidia. D. Mature conidia. E. Conidiophores formed in culture on CMA. Arrows indicate vesicle-like outer wall.


A
B
C
D
E
20µm

Colonies were restricted on all media used, and did not exceed 6-7 mm diameter after two months' growth.

Goos (1986) monographed the genus *Helicoma*, recognizing 32 species and four sections. The sections are delimited primarily on mode of conidial development and conidium attachment to the conidiogenous cell. *Helicoma vaccinii* fits well in Sect. *Helicoma*, a group comprised of species with conidia borne acrogenously on distinct denticles. Goos (1986) noted the morphological similarities between the ten species in Sect. *Helicoma*. There is considerable overlap in characters, including: conidiophore length; number of septa; and number of coils in the conidium. The diagnostic characters most useful in differentiating species include diameter of conidia and width of conidial filaments. Nine of the species in Sect. *Helicoma* produce conidia >13 μm in diameter. Only *H. taiwanensis* Matsushima has relatively small conidia (7-15 μm in diameter) in the size range of the conidia of *H. vaccinii*. The conidia of *H. taiwanensis* are otherwise different from the conidia of *H. vaccinii* in having wider conidial filaments (4.0-6.0 μm versus 2.5-4.5 μm for *H. vaccinii*) and blunt basal cells. In addition, *H. taiwanensis* produces a second, phragmosporous type of conidium and conidiophores with multiple, inflated conidiogenous nodes (Matsushima, 1983).

Goos (1986), Linder (1931), and Pirozynski (1972) noted the shape of the conidium basal cell as a useful character for differentiating *H. muelleri* and *H. ambiens*, two morphologically similar species in Sect. *Helicoma*. Likewise, the long, tapering basal cells of *H. vaccinii* (5.4-14.7 μm in length) distinguish this fungus from other species in Sect. *Helicoma*. For example, the basal cells of *H. muelleri* conidia (IMI 78575) are 4.7-6.7 μm long.

The conidiogenous cells of *H. vaccinii* are predominately monoblastic, both on host tissue and in culture (Figs. 1B, 1E, 4-6, 9). Occasionally, conidiogenous cells with 2-3 denticles are found. More frequently, the

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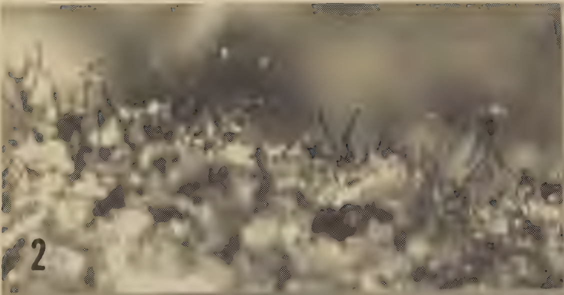
Figs. 2-13. *Helicoma vaccinii*. 2. Conidiophores on *Vaccinium elliotii*. X 90. 3. Conidiophores formed in culture on CMA. X 600. 4, 5. Conidiophore apices. Note denticles. X 1400. 6. Proliferation of conidiophore apex with ruptured outer wall. X 1400. 7, 8. Immature conidia. X 2000. 9. Conidiophore formed on CMA. X 800. 10, 11. Mature conidia. X 1000. 12, 13. Conidiophores developing from cells of conidia. X 600.



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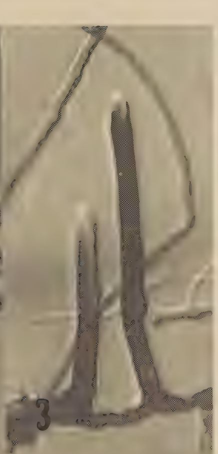

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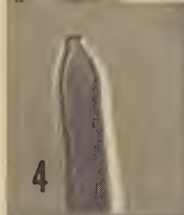

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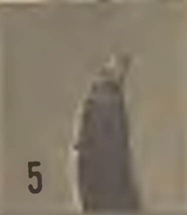

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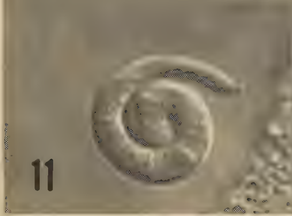

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conidiogenous cells proliferate percurrently, with a new conidiogenous cell emerging through the ruptured darkened outer wall of the conidiophore apex (Figs. 1B, 6). This type of proliferation was illustrated by Pirozynski (1972) for the *H. muelleri* anamorph of *Tubeufia pezizula* [cited as *Thaxteriella pezizula* (Berk. & Curt.) Petrak]. An illustration of a conidiophore apex of *H. ambiens* (Goos, 1980; Fig. 29) also resembles the conidiogenous cell proliferation in *H. vaccinii* shown in Fig. 6.

Germination of *H. vaccinii* conidia frequently occurs from the basal cell, in a way similar to *H. muelleri* as reported by Linder (1929), but germ tubes may develop from any cell in the conidium of the former. In colonies on CMA and MEA, conidia often become swollen and melanized, giving rise directly to conidiophores (Figs. 1A, 12, 13).

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LONG-CHAIN FATTY ACID COMPOSITION AS A TOOL FOR DIFFERENTIATING SPOILAGE WINE YEASTS

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SUMMARY

The use of conventional methods for yeast identification is not pratical enough for industrial application due to the complexity and morosity of the techniques. Furthermore, misinterpretation of the results is frequent. The use of chemotaxonomic methods for pratical uses enables a faster and easier identification. In this work the analysis of long-chain fatty acids was used to differentiate several yeast strains belonging to the genera *Saccharomyces, Zygosaccharomyces, Torulaspora, Candida* and *Pichia.*

INTRODUCTION

The identification of yeasts according to morphological, sexual, physiological and biochemical characteristics has been traditionally used by Lodder (1970), Barnett *et al.* (1983) and Kreger-van Rij (1984). The work of Lodder (1970) and Kreger-van Rij (1984) results from a revision of the book edited formerly by both authors (Lodder and Kreger-van Rij, 1952). Unfortunately for those who deal with practical aspects of yeasts the frequent changes of nomenclature make the identification more difficult, due to an increase in the synonymy among the species classified by these authors in their different editions, which led van der Walt (1987) to propose that the fermentation industry should develop a specific taxonomy.

Nowadays the more significant developments on taxonomy are due to molecular methods (for a review see Kurtzman and Phaff, 1987). The chemical constituition of each microorganism is regarded as a result of natural evolution and so, the species with similar composition are seen as being closely related. The fact that the above mentioned methodologies are time consuming and/or of difficult industrial use, lead to the development of more rapid techniques, such as analysis of compounds and metabolites. These, by revealing also a phylogenetic relatedness, enable an easier practical delimitation of species.

Among other compounds analysed are the long-chain fatty acids, which have been used with several microorganisms since the work of Abel *et al.* (1963) using bacteria. In our work we tried to differentiate several spoilage wine yeasts based on the cellular long-chain fatty acid composition following, primarily, the methodology proposed by Lategan and his co-workers (Kock *et al.* 1985, 1986; Cottrell *et al.* 1985, 1986; Viljoen *et al.* 1986, 1987, 1988; Tredoux *et al.* 1987a, 1987b). The spoilage wine yeasts can be divided into three main groups: the film-forming (e. g. *Candida vini, Pichia membranaefaciens* and *Brettanomyces* spp.), the fermenting (*Saccharomyces cerevisiae*), and those of more difficult control, the "sensu stricto" spoilage yeasts (e.g. *Zygosaccharomyces bailii*). Our aim was to obtain a test which could rapidly determine whether or not the isolated yeasts belonged to the species more dangerous to wine stability. *Z. bailii* is difficult to differentiate from *Torulaspora delbrueckii* when the sexual conjugation is not evident. Therefore several strains of these species, isolated from other origins, were also analysed.

MATERIAL AND METHODS

The yeast strains were either obtained from the yeast culture collection of the Instituto Gulbenkian de Ciência (IGC), Oeiras, Portugal, or isolated from Portuguese bottled dry white wines with "sandy" sediments (table 1). Stock cultures of all strains were maintained on Wickerham agar slopes and the isolation was made by plating, using the same medium. All isolated strains were identified according to conventional methods (Barnett *et al.* 1983, and Kreger-van Rij, 1984) in the IGC laboratory.

Growth on liquid medium followed the methodology proposed by Kock *et al.* (1985). Cells were grown in 250 mL Erlenmeyer flasks with 80 mL of medium composed by 80 $g.L^{-1}$ glucose (Merck) and 6.7$g.L^{-1}$ Yeast Nitrogen Base (YNB) (Difco) at 30±0.1 C for 16 h, in a water bath with magnetic stirring. Then, 10 mL of the suspension were transferred to 1 L Erlenmeyer flasks with 400 mL of the previous medium, in the same environmental conditions, for 48 h. The cells were harvested during the stationary phase by centrifugation and washed twice with cold demineralized water. The biomass obtained was either freeze dried or used immediately. For growth on solid medium the cells, from stock cultures, were suspended in Ringer solution and a drop was placed in plates of Wickerham agar. Incubation was carried at 25±0.1 C for 48 h, after which the biomass was taken from the agar and used immediately.

The cellular long-chain fatty acids were extracted and methylated according to Moss *et al.* (1974), using a solution of 5% (w/v) NaOH in 50% (v/v) aqueous methanol and borontrifluoride methanol (Merck). The final methyl ester mixture was evaporated under a nitrogen stream and redissolved in hexane. The samples were analysed in a gas chromatograph (Perkin Elmer 8410) with a FID detector, using a stainless steel column (1/8 in x 3.5m) packed with 8% Carbowax 20M W-AW (100-120 mesh). The column temperature was 230 C at an outlet N_2 flow of 40 mL. min^{-1}. The methyl ester identification was done by retention times of myristic (C14:0), myristoleic (C14:1), palmitic (C16:0), palmitoleic (C16:1), stearic (C18:0), oleic (C18:1), linoleic (C18:2) and linolenic (C18:3) acid esters, relative to the palmitic acid ester. The peak areas were determined by automatic integration and the results, for each ester,

Table 1. List of analysed yeast strains

Species	Designation	Origin[a]
Saccharomyces cerevisiae Meyen ex Hansen	A000 and A063	Commercial wine starters
S. cerevisiae (syn.[b] *S. bayanus* Saccardo)	A065	Commercial wine starter
S. cerevisiae (syn. *S. bayanus* Saccardo)	A028, A026 and A029	Isolated from bottled wines
Zygosaccharomyces bailii (Lindner) Guilliermond	A006	Type strain, IGC 2470, CBS 680
Z. bailii (Lindner) Guilliermond	G227	IGC 4227, NRRL S9 144
Z. bailii (Lindner) Guilliermond	A022, A023, A024, A025, A027 and A031	Isolated from bottled wines
Z. bailii (Lindner) Guilliermond (syn. *Saccharomyces elegans* Lodder & Kreger-van Rij)	G899	IGC 2899
Pichia membranaefaciens (Hansen) Hansen	A030	Isolated from bottled wines
Candida vini (Desmazières) van Uden & Buckley	A007	IGC 2597, CBS 639
Torulaspora delbrueckii (Lindner) Lindner	G166	Type strain, IGC 4166, CBS 1146, NRRL Y-886
T. *delbrueckii* (Lindner) Lindner (syn. *Saccharomyces delbrueckii* Lindner)	G477	IGC 2477
	G500	IGC 2500, kefyr grains
	G501	IGC 2501, kefyr grains
	G502	IGC 2502, bottled kefyr
T. *delbrueckii* (Lindner) Lindner (syn. *Saccharomyces rosei* (Guiliermond)Lodder & Kreger-van Rij)	G209	IGC 3209, CBS 865, potato starch
	G713	IGC 2713, CBS 817
T. delbrueckii (Lindner) Lindner (syn. *S. rosei* and *Schwanniomyces hominis* Batista *et al.*)	G844	IGC 2844, human skin
T. delbrueckii (Lindner) Lindner (syn. *S. rosei* and *Torulopsis stellata* (Kroemer & Krumbholz) Lodder var. *cambresieri* Lodder & Kreger-van Rij)	G907	IGC 2907
	G911	IGC 2911, CBS 158, sugar
	G998	IGC 2998, man
	G999	IGC 2999, seawater
T. delbrueckii (Lindner) Lindner (syn. *Torulopsis colliculosa* (Hartmann) Saccardo)	G916	IGC 2916, CBS 133, javanensi ragi
Unindentified strains	A032, A033, A067, A068, A069, A070, A071, A072, A074, A075, A076, A077, A078, A079, A080, A081 and A082	Isolated from bottled wines

a) Abbreviations: IGC, Instituto Gulbenkian de Ciência, Oeiras, Portugal; CBS, Centraalbureau voor Schimmelcultures, Delft, The Netherlands and NRRL, Northern Regional Research Center, US Department of Agriculture, Peoria, Illinois, USA.

b) Synonyms of the species described by Barnett et al. (1983) and Kreger-van Rij (1984).

expressed as a percentage by weight of the total area.

Principal Component Analysis (PCA) enables us to analyse observed values of a set of continous variables (in our case, percentages of fatty acids) for a set of experimental units (in our case, yeast strains), in order to build new variables, called principal components, which represent the directions of the axes of greatest variability. By projecting the initial variables on the planes defined by the first few principal components, we obtain graphical representations whose appropriate analysis enables the identification of the principal contrasts among the initial continuous variables. The coordinates of the strains in the first four axes were used to perform an ascending hierarchical classification according to the reciprocal neighbours method. Next, we apply a cut-off in the dendogram obtained from the hierarchical classification, this obtaining three classes which were characterized by the initial variables. All these analyses were carried out by the SPAD (Système Portable pour l'Analyse des Données) software (Lebart *et al.* 1985).

RESULTS AND DISCUSSION

The results from growth in liquid medium (Fig. 1) showed a clear distinction between the yeast groups previously established, enabling their separation in agreement with their practical spoilage importance. Other authors (Tredoux *et al.* 1987a, 1987b) have characterized a larger number of yeasts but the groups proposed have not a consistent enological meaning.

The methods in wine microbiological control should give rapid results and be simple to operate, therefore, in order to reduce time of analysis and to simplify the procedures, the yeasts were grown on solid medium. The fatty acid profiles (Fig. 2) were similar to those obtained on liquid medium with the same basic differences among the three groups. The major difference is on the percentage of C18:2 in *Z. bailii* strains, but this does not affect the distinction among the three groups. The influence of growth conditions on the fatty acid composition is largely referred in literature (for a review see Ingram and Buttke, 1984, and van Uden, 1985). This similarity of the profiles in different conditions was, therefore, somewhat unexpected although, probably, the media composition and incubation conditions are not distinct enough to produce large differences. For example, Hunter and Rose (1972) had already noticed that there was little change in the fatty acid composition of *S. cerevisiae* cells grown at 15 C and 30 C. These results are of particular importance to industry because the procedures are simplified and, principally, because it is possible to make the analysis directly from microbiological control plates, if the biomass grown is enough for the determination.

The statistical treatment by PCA establishes a correlation matrix, comprising the long-chain fatty acid compositions for each strain. This allows distribution of the strains in a projection plan according to their fatty acid similarities, confirming the differences between the three spoilage yeast groups (Fig. 3). The unindentifyed strains A068, A070, A074, A076, A077, A079, A081 and A082 were clustered on the *S. cerevisiae* group, strains A032, A067, A075, A078, and A080 were in the *Z. bailii* group, and strains A033, A069, A071 and A072 were in the *P. membranaefaciens* group (Fig. 3). Further tests, on a larger number of strains and species, are being made in order to improve the reliability of this analysis. for that it will be necessary to ensure the stability of the defined clusters. If this analysis proves suitable it will be possible to create a data bank allowing a direct yeast identification according to its phylogenetic proximity.

The PCA of the thirteen studied strains of *T. delbrueckii* showed that their fatty acid profiles are clearly different from those of the *Z. bailli* strains (Fig. 4). In fact, whereas all strains of *Z. bailli* appear in one single cluster, except for one strain, G899 formerly classified as *Saccharomyces elegans*, strains of *T. delbrueckii* are

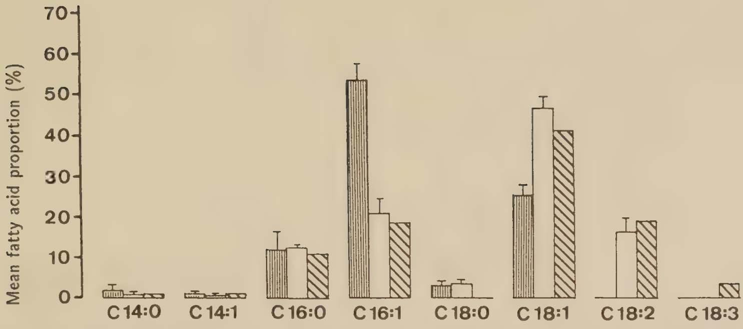

Fig. 1 - Long-chain fatty acids profiles from strains grown on Wickerham liquid medium, at 30 C for 48h. ▥-Fermenting yeasts, *S. cerevisiae* A000, A063, A065, A028 and A029. □-"Sensu stricto" spoilage yeasts, *Z. bailii* A006, A024, A027 and A031. ▧-Film-forming yeast, *P. membranaefaciens* A030. Results are the mean of two or three replicates. Standard deviations indicated by small vertical bars.

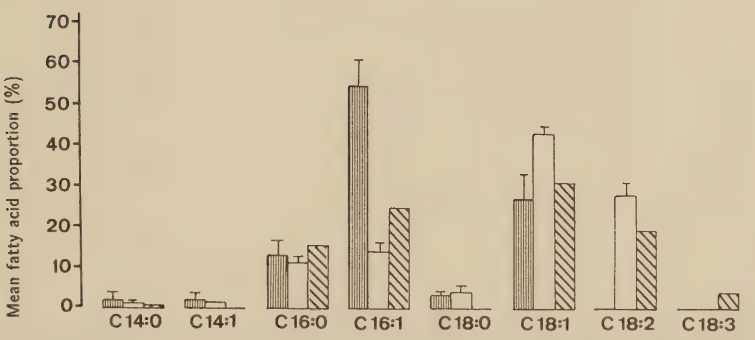

Fig. 2 - Long-chain fatty acids profiles from strains grown on Wickerham solid medium, at 25 C for 48h. ▥-Fermenting yeasts, *S. cerevisiae* A000, A063, A065, A028, A026 and A029. □-"Sensu stricto" spoilage yeasts, *Z. bailii* A006, G227, A022, A023, A024, A025 and A031. ▧-Film-forming yeast, *P. membranaefaciens* A030. Standard deviations indicated by small vertical bars.

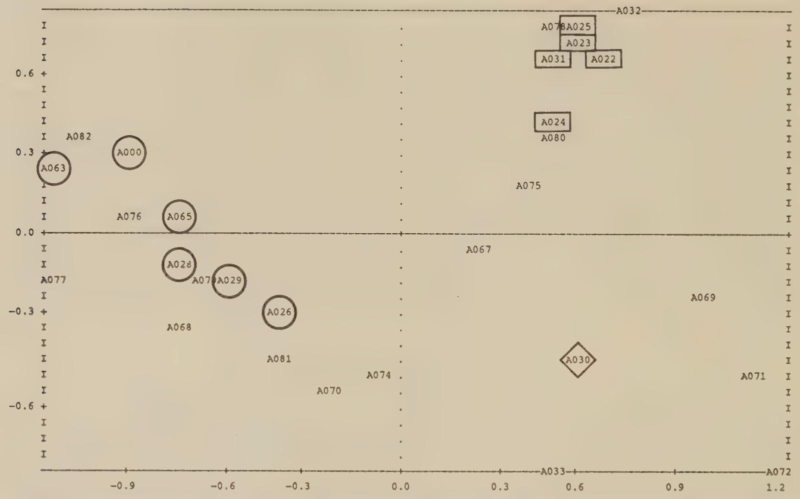

Fig. 3 - Projection plan of the yeasts, isolated from wines and from commercial wine starters, on the axes 1 (horizontal) and 2 (vertical). *S. cerevisiae* ○ ; *Z. bailii* □ ; and *P. membranaefaciens* ◇ . Unidentified strains do not have symbols.

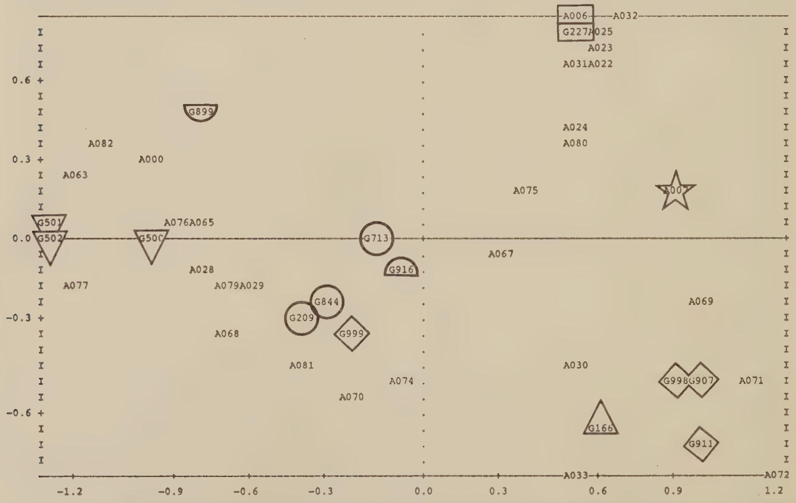

Fig. 4 - Projection plan of the yeasts, isolated from wines, from commercial wine starters and from other origins, on the axes 1 (horizontal) and 2 (vertical). *S. rosei* and *S. hominis* ○; *S. delbrueckii* ▽; *T. stellata* var. *cambresieri* ◇ ; *T. colliculosa* ⌓; *T. delbrueckii* (type strain) △ ; *S. elegans* ◡; *Z. bailii* □ ; and *C. vini* ☆. Strains isolated from wines and from commercial wine starters do not have symbols, the yeasts isolated from other origins are considered illustratives, not influencing the definition of the axes. Strains A026, A078 and G477 are covered by strains G209, G227 and G501, respectively.

scattered on the projection plan. Nevertheless it was possible to distinguish several subgroups among strains of the species now considered as *T. delbrueckii* (Barnett *et al.* 1983, and Yarrow, 1984), approximately related to the former classification for the species *S. delbrueckii*, *S. rosei* and *T. stellata* var. *cambresieri*.

From all this a question arises: are the former classifications more consistent, in phylogenetic terms, than the present ones (Barnett *et al.* 1983, and Yarrow, 1984)?

Although the number of studied strains is too small to enable a definite conclusion, our results showed that the long chain fatty-acid composition might be of great convenience in the distinction between *Z. bailii* and *T. delbrueckii*.

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DESCRIPTION OF THE ANAMORPH OF VALSEUTYPELLA MULTICOLLIS IN CULTURE

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INTRODUCTION

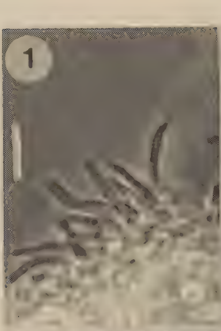
The genus *Valseutypella* Höhnel is characterized by its receptacle-shaped stroma formed by pseudoparenchymatous and sclerotial cells.

This genus had remained monospecific until the description of *V. multicollis* Checa, Moreno & Barr (Checa et al., 1986), which differs from the type species *V. tristicha* (de Not.) Höhnel, by its larger stromata containing numerous perithecia, as well as by the size of its ascospores and its habitat. *Valseutypella tristicha* is host specific on *Rosa* spp., whereas the Spanish species occurs on *Quercus ilex* ssp. *rotundifolia*.

The anamorph of *V. tristicha* belongs to the genus *Cytospora* (Hubbes, 1960) and has not been described in detail. The anamorph of *V. multicollis* also belongs to *Cytospora*.

METHODS

With ascospores of *V. multicollis*, obtained from stromata grown on wood of *Quercus ilex* ssp. *rotundifolia*, we started cultures in PCA (potato carrot agar) with antibiotic. The fungus is conserved at the fungal culture collection of the CIB (IJFM) as IJFM A-522. After several months of incubation at room temperature, we observed the production of pycnidia, more quickly and abundantly on MEA (malt agar).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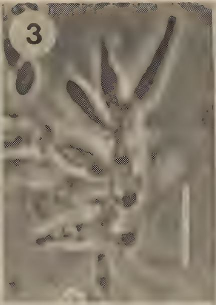
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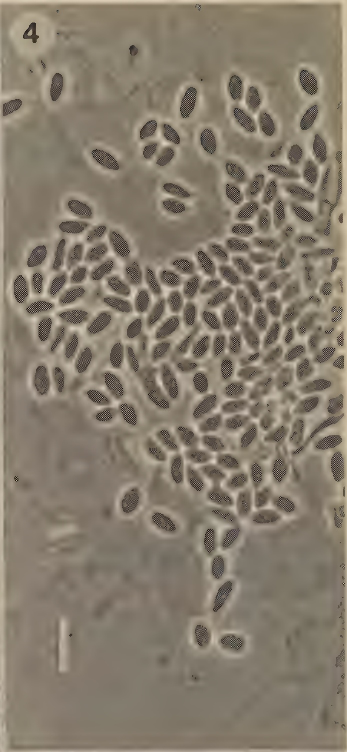
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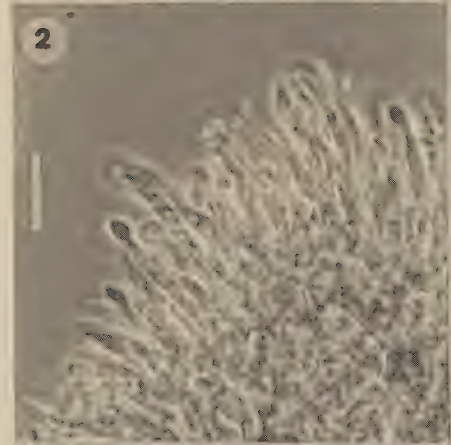
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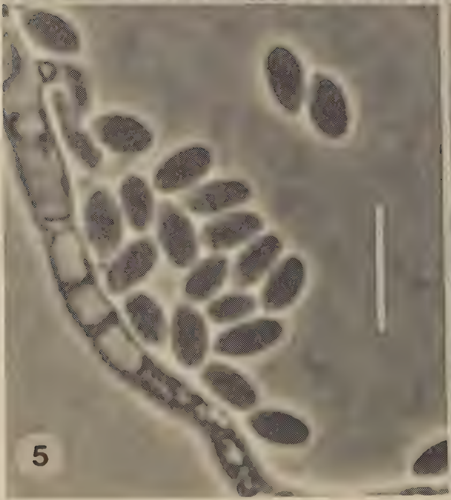
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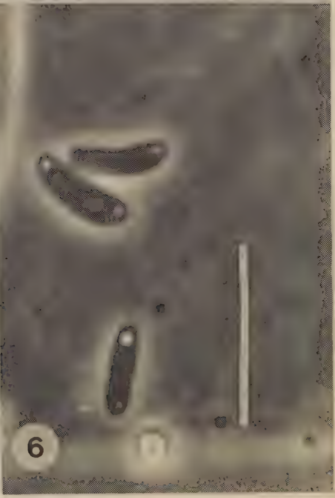
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DESCRIPTION

Colonies on MEA growing quickly with scarce aerial mycelium. Producing a diffusible dark brown pigment and forming abundant pycnidia in concentric zones. Pycnidia black, variable in size (300-700 µm), stromatic, globose to pyriform, with one or several ostioles, which disperse the conidia by means of drops of exudate. Phialides cylindrical (Figs. 1-2) sometimes narrowed at the base, 8-18 x 1,5-2 µm, in verticils of 3-5, on branched hyphae which grow filling up the greater part of the pycnidial cavity (Fig.3). Conidia hyaline, cylindrical-oval in front view (Figs.4-5), allantoid in side view (Fig.6) and becoming ellipsoidal (4-6 x 2,5 µm) and apiculated on one end. None of the cultures developed perithecia.

The comparison with the anamorph of *V. tristicha* (CBS 465.59) was not possible because this strain did not produce pycnidia in culture.

DISCUSSION

This pycnidial form must be placed in the genus *Cytospora* because of its stromatic pycnidia with dark walls, cylindrical and verticillated phialides not restricted to the base of the pycnidial cavity, and particularly because of the presence of allantoid conidia. However it includes ellipsoidal forms too, thus being different from the greater part of the species of *Cytospora*.

The definitive clarification of the systematic position of the anamorphs of *Valseutypella* continues the revision of the genus *Cytospora*, which includes anamorphs of *Valsa* (Spielman, 1985) and *Leucostoma*, as well as numerous anamorphic species whose variability in culture has to be determinated (Sutton, 1980).

We thank Dr. M.E. Barr of the University of Massachusetts, for reviewing the manuscrip and Mr. M. Heykoop for the English corrections.

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Figs.1-6: *Cytospora* sp. 1-2.- Cylindrical phialides, verticils, on branched conidiophores. 3.- Branched conidiogenous hyphae in the pycnidial cavity. 4-5.- Oval to ellipsoidal conidia. 6.- Allantoid conidia. The bars indicate 10 µm .

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STUDIES ON J. B. CLELAND'S FUNGAL HERBARIUM - 2: CORTINARIUS SUBGENUS MYXACIUM (CORTINARIALES)

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Abstract

Collections of Cortinarius, subgenus Myxacium in the J.B. Cleland herbarium have been re-examined. Of the seven species described and the one recorded from South Australia, five are accepted, two are treated as synonyms, and one new species is described: Cortinarius bundarus.

Introduction

Cortinarius subgenus Myxacium is distinguished from other subgenera by the gelatinizing universal veil. This subgenus contains small to large fleshy species with brown, yellow, blue or vinaceous-red pigmentation. Pigment is epimembranal intercellular or plasmatic. Hyphae of the cuticle are 7-20 µm wide, the spores are verrucose, subglobose to amygdaliform or lemon-shaped. Cheilocystidia are present or absent. (Singer, 1986:635).

J.B. Cleland described or recorded eight species within this subgenus. Fresh material could not be obtained to supplement the macroscopic descriptions provided by Cleland or to amplify distributional data. The macroscopic descriptions in this paper are adapted from Cleland's handbook (1934-1935), his papers (1928 & 1933), and the collection notes accompanying each collection. Cleland recorded colours using the colour handbook of Ridgway (1912). In this study, microscopic data were recorded from fragments of basidiome stained with ammoniacal Congo Red and then mounted in a 3% aqueous solution of potassium hydroxide.

KEY TO THE INCLUDED SPECIES OF SUBGENUS MYXACIUM

1. Basidiome red..................*C. erythraeus* 1.

1*. Basidiome differently coloured..............2.

2. Basidiome yellowish brown......................3.

2*. Basidiome with lilac or violet tints.........4.

3. Spores approaching subfusiform, 12.2-18.0 x 7.0-9.9 µm......................*C. subarvinaceus* 2.

3*. Spores ellipsoid, 6.8-9.4 x 4.6-5.7 µm..................................*C. sinapicolor* 3.

4. Pileus whitish to light buff; lamellae ochraceous buff; stipe with a trace of violet; odour of fenugreek when dry..........*C. austroalbidus* 4.

4*. Pileus violet-brown or violet becoming brown; lamellae violet-tinted; stipe pallid to pale violet or violet...........................5.

5. Stipe with a distinct annulus, deep dull bluish violet below, pallid above; spores large, amygdaliform, 11.4-15.8 [-17.6] x 6.4-8.6 [-9.4] µm.......................................*C. archeri* 5.

5*. Stipe with a cortina, paler than above; spores smaller, short ellipsoid to elongate ellipsoid, up to 11.6 µm long...........................6.

6. Spores short ellipsoid to ellipsoid, 6.4-8.6 x 4.8-8.3 µm.................. *C.microarcheri* 6.

6*. Spores ellipsoid to elongate ellipsoid or approaching cylindric, longer than 8.6 µm....7.

7. Spores elongate ellipsoid, sometimes approaching cylindric, 8.6-11.6 x 4.8-6.1 µm...*C. subarcheri* 7.

7*. Spores ellipsoid, 9.4-10.8 [-11.6] x 6.0-7.3 µm..................................*C. bundarus* 8.

1. *Cortinarius erythraeus* Berk. Fig. 1 A-B.

Cortinarius erythraeus Berk. in Lond. J. Bot. 4:48, 1845.
C. ruber Clel. in Trans. R. Soc. S. Australia 51: 303-304, 1927.

PILEUS up to 51 mm diam., convex, then irregularly wavy and convex, subgibbous, viscid, near Dragon's Blood Red (XIII) passing into Rufous (XIV); flesh white, moderately thick over the stipe, thinning outwards. LAMELLAE slightly sinuately adnexed, moderately close, a little ventricose, Tawny Olive (XXIX). STIPE up to 38 mm long, rather short and stout, bulbous, to 19 mm diam. below and to 13 mm diam. above, viscid, solid or somewhat hollow, whitish and slightly striate above, concolorous with the pileus below the remains of the veil, with some yellowish mycelium at the base and whitish rooting mycelial strands below, flesh discoloured. CORTINA glutinous, yellowish red or red.

BASIDIOSPORES (55/6)[1], 8.0 - 11.0 ($\bar{x}$=9.8) x 5.9 - 8.3 ($\bar{x}$=6.9) µm, L/B=1.4[2], ellipsoid, finely warty rough, slightly thick-walled, pale yellowish brown in 3% aqueous solution of potassium hydroxide. BASIDIA (27/5), [23.2-] 32.0 - 51.2 ($\bar{x}$=36.9) x 8.6 - 13.0 ($\bar{x}$=10.6) µm, with sterigmata up to 4.8 µm long, four-spored, clavate. CYSTIDIA not observed. UNIVERSAL VEIL of filamentous, smooth, gelatinized hyphae, (38/2), 2.0 - 7.4 ($\bar{x}$=5.0) µm diam. CLAMP CONNECTIONS present.

HABIT, HABITAT AND PHENOLOGY - gregarious, occasionally solitary or subcaespitose on the ground under eucalypts. Specimens collected in June and July.

MATERIAL - SOUTH AUSTRALIA: Kinchina, 7.vii.1923, AD 4291, Miss J. Buxton, watercolour no. 12 (syntype of *C. ruber*). Belair Recreation Park, 21.vii.1923, AD 4290; 5.vii.1924, AD 4289 (syntype of *C. ruber*); 12.vi.1952, AD 4287. Morialta, 3.vi.1933, AD 4284; 3.vii.1937, AD 4288. Mt Bold, 9.vii.1939, AD 4286.

The orange to blood-red glutinous universal veil indicates that this species belongs in Section *Pyromyxae* (Moser & Horak, 1975: 227, 229, 574; Singer, 1986:636).

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[1] (55/6), fifty-five measurements from six collections (see Bas, C. p. 290 (1969)).

[2] L/B., length-breadth ratio

2. Cortinarius subarvinaceus Clel. Fig. 2 A-B.

Cortinarius subarvinaceus Clel. in Trans. R. Soc. S. Australia 51:304, 1927.

PILEUS 46 - 87 mm diam., convex sometimes repand, finally irregularly revolute, edge a little involute, sometimes substriate round the edge, very viscid, Mars Yellow (III), Ochraceous Tawny (XV), becoming much darker and shining in the centre; flesh slightly brownish, when old becoming semi-translucent, thick over the disc, thin outwards, cuticle thick and dark brown. LAMELLAE adnate or subsinuate, moderately close, slightly ventricose, pallid greyish cinnamon then Raw Sienna (III), Sayal Brown (XXIX) or Tawny Olive (XXIX) and darker. STIPE 37 - 75 mm long, stout, to 17 mm diam., cylindric or base sometimes slightly bulbous, mealy, fibrillose, base viscid, whitish becoming brownish. SPORE PRINT near Tawny Olive (XXIX).

BASIDIOSPORES (70/4), 12.2 - 18.0 ($\bar{x}$=14.6) x 7.0 - 9.9 ($\bar{x}$=8.4) µm, L/B=1.7, approaching subfusiform with the apices often drawn into obtuse mucrones, finely warty rough, slightly thick-walled, yellowish brown in 3% aqueous solution of potassium hydroxide. BASIDIA (27/3), 34.4 - 50.0 ($\bar{x}$=43.9) x 11.2 - 16.0 ($\bar{x}$=13.7) µm, with sterigmata up to 7.2 µm long, four-spored, clavate. CYSTIDIA absent. UNIVERSAL VEIL of repent, filamentous, loosely tangled hyphae, (40/1), 2.4 - 7.6 ($\bar{x}$=4.3) µm diam., gelatinized, hyaline, cuticle to 460 µm deep, subcuticular hyphae with pale reddish brown internal pigment, oleiferous hyphae scattered, cylindric, dark reddish brown. CLAMP CONNECTIONS not observed.

HABIT, HABITAT AND PHENOLOGY - gregarious, occasionally solitary or subcaespitose on the ground under eucalypts. Specimens collected from April to July.

MATERIAL - SOUTH AUSTRALIA: Mt Lofty, 25.iv.1921, AD 4323. Stirling West, 23.vii.1927, AD 4328 (holotype). Encounter Bay, 24.v.1928, AD 4322. Mt Robinson, via Upper Willow Creek, Encounter Bay, 30.v.1939, AD 4325. Echunga, 12.v.1939, AD 4326.

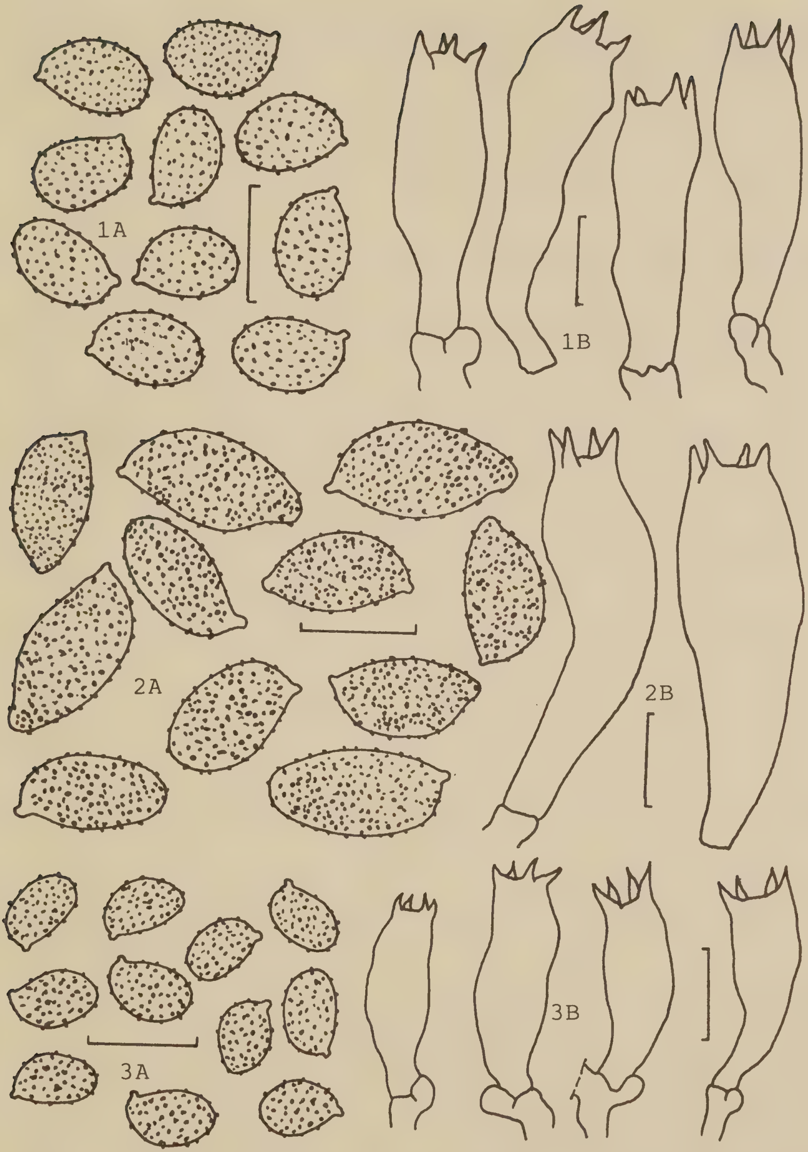

Fig. 1. Cortinarius erythraeus.- A. Basidiospores. B. Basidia. Fig. 2. C. subarvinaceus.- A. Basidiospores. B. Basidia. Fig. 3. C. sinapicolor - A. Basidiospores. B. Basidia. Bars = 10 µm.

The large subfusiform spores and absence of clamp connections indicate that this species belongs in Section Defibulati, as defined in Singer (1986:637).

3. Cortinarius sinapicolor Clel. - Fig. 3 A-B

Cortinarius sinapicolor Clel. in Trans. R. Soc. S. Australia 57:191, 1933.
C. ochraceus Clel. in Trans. R. Soc. S. Australia 51: 304, 1927 non Peck.

PILEUS up to 76 mm diam., slightly convex to convex, sometimes umbonate, then repand, finally irregularly upturned, edge sometimes undulating, very glutinous, Mustard Yellow (XVI), Yellow Ochre (XV) or Citrine Drab (XL) but with a brownish tinge around the edge, with the centre darker or passing into Amber Brown (III); flesh soapy-looking, thick over the disc, rapidly attenuated outwards. LAMELLAE adnate to sinuately adnexed, moderately close to close, to 8 mm deep, Buffy Brown (XL) when young, then near Sudan Brown (III) or Buckthorn Brown (XV). STIPE up to 76 mm long, moderately slender to moderately stout, to 13 mm diam., flexuous, base a little bulbous with white mycelial threads, then cylindric, striate or fibrillose above, very glutinous, pallid becoming yellowish brown or tinted yellow, flesh turning slightly watery yellowish. CORTINA pale yellowish.

BASIDIOSPORES (50/1), 6.8 - 9.4 ($\bar{x}$=8.0) x 4.6 - 5.7 ($\bar{x}$=5.0) µm, L/B=1.6, ellipsoid, finely warty rough, slightly thick-walled, yellowish brown in 3% aqueous solution of potassium hydroxide. BASIDIA (25/1), 22.4 - 32.8 ($\bar{x}$=26.5) x 6.8 - 10.0 ($\bar{x}$=8.6) µm, with sterigmata up to 5.6 µm long, four-spored rarely two-spored, clavate. CYSTIDIA not observed. UNIVERSAL VEIL of repent, filamentous hyphae, (31/1), 2.8 - 7.0 ($\bar{x}$=4.6) µm diam., radially arranged, loose, gelatinized, with abundant epimembranal pigment. CLAMP CONNECTIONS present.

HABIT, HABITAT AND PHENOLOGY - gregarious on the ground under eucalypts. Specimens collected in June and July.

MATERIAL - SOUTH AUSTRALIA: Mt Lofty, 9.vii.1927, AD 4246 (holotype of *C. ochraceus*). Belair Recreation Park, 20.vi.1931, AD 4654 (holotype of *C. sinapicolor*).

Moser and Horak (1975:574) recorded *Cortinarius ochraceus* Clel. non Peck as a variety (var. *australiensis*) of *C.paraochraceus* Moser. However, examination of the holotype of *C. ochraceus* Clel. non Peck has shown it to have smaller spores than those quoted for *C. paraochraceus* var. *australiensis* Moser: 6.8 - 9.4 ($\bar{x}$=8.6) x 4.9 - 5.6 ($\bar{x}$=5.2) µm as compared to 8.5 - 10.5 x 4.3 - 5.2 µm for the latter variety. Moser and Horak did not examine the holotype of *C. ochraceus* Clel. non Peck, but rather another collection with larger spores, belonging to a different species (Mt Lofty, 19.vi.1921, AD 4243).

The yellowish to ochraceous pileus, brownish lamellae, cylindric, non radicating stipe, and gregarious habit indicate that this species belongs in Section *Pyromyxae*, as defined in Singer (1986:636).

4. *Cortinarius austroalbidus* Fig. 4 A-B

Cortinarius austroalbidus Clel. & Harris in Rec. S. Aust. Mus. 9:54, 1948.
C. albidus Clel. in Trans. R. Soc. S. Australia 57: 191, 1933 non Fr.

PILEUS 37 - 62 mm diam., convex becoming plane, subumbonate, glutinous, smooth, edge subfibrillose when old, white with occasional tints of Light Buff (XV), when old near Light Buff (XV); flesh thin, attenuated outwards, with a very faint tint of violet. LAMELLAE sinuately adnexed, moderately close, ventricose, up to 9 mm deep, Light Ochraceous Buff (XV) to near Ochraceous Buff (XV). STIPE up to 62 mm long, moderately stout, to 13 mm diam., cylindric or slightly bulbous below, sticky, fibrillose, white with a very faint tint of violet. VEIL brownish. ODOUR of fenugreek when dry.

BASIDIOSPORES (52/1), 9.3 - 11.6 [-12.8] ($\bar{x}$=10.4) x 5.8 - 7.4 ($\bar{x}$=6.5) µm, L/B=1.6, ellipsoid to elongate ellipsoid, finely warty rough, slightly thick-walled, pale yellowish brown in 3% aqueous solution of potassium hydroxide. BASIDIA (24/1), 28.2 - 40.0 ($\bar{x}$=33.6) x 8.2 - 11.7 ($\bar{x}$=9.4) µm, with sterigmata up to 5.2 µm long, four-spored, clavate. CYSTIDIA absent. UNIVERSAL VEIL of filamentous, gelatinized hyphae, (31/1), 2.4 - 6.0 ($\bar{x}$=3.8) µm diam., loosely repent, undulating, pigment not seen. CLAMP CONNECTIONS not seen.

HABIT, HABITAT AND PHENOLOGY - gregarious on the ground under eucalypts. Specimen collected in June.

MATERIAL - SOUTH AUSTRALIA: Belair Recreation Park, 29.vi.1932, AD 4113 (holotype).

The small to medium-sized basidiome, whitish pileus, pale lamellae, and clavate to somewhat bulbous stipe indicate that this species belongs in Section _Malvacei_, as defined in Singer (1986:638).

5. _Cortinarius archeri_ Berk. - Fig. 5 A-B

Cortinarius archeri Berk. in Hook. f. Fl. Tasm. _2_: 247, t.181/7, 1860.

PILEUS 63 - 89 mm diam., deeply convex then convex becoming plane, finally often with upturned edges and irregular, or with deep depressions and bosses, very viscid, deep violet becoming brown (Verona Brown (XXIX) to Bistre (XXIX) with a violet tint); flesh thin except over disc. LAMELLAE slightly sinuate to adnate, moderately close, to 10 mm deep, sometimes with reticulated ridges on the sides, Snuff Brown (XXIX) with a violet tint, especially on the edges. STIPE 63 - 89 mm long, stout, 18 - 25 mm diam. or more, at first bulbous below, usually slightly attenuated in the middle, sometimes flattened, striate above, hollow below, Deep Dull Bluish Violet (XXIV) below the glutinous subdistant ring, paler lilac above.

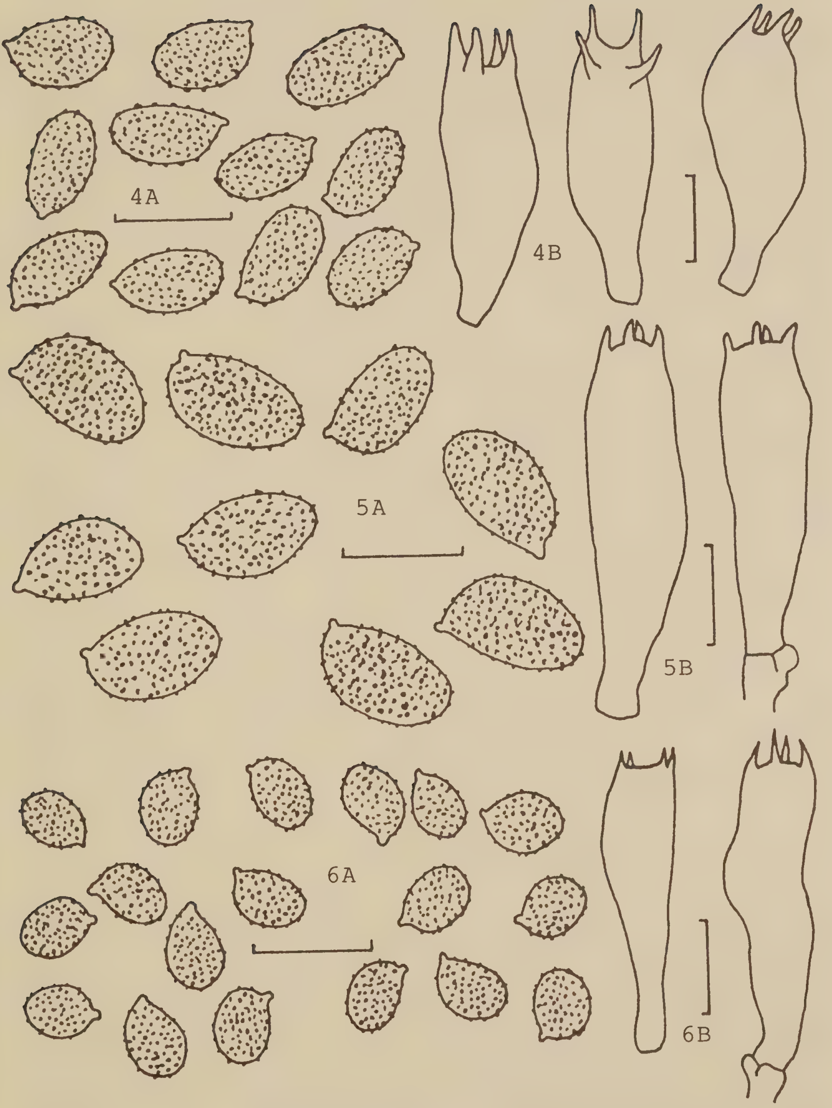

Fig. 4. Cortinarius austroalbidus.- A. Basidiospores. B. Basidia. Fig. 5. C. archeri.- A. Basidiospores. B. Basidia. Fig. 6. C. microarcheri - A. Basidiospores. B. Basidia. Bars = 10 µm.

BASIDIOSPORES (61/5), 11.4 - 15.8 [-17.6] ($\bar{x}$=13.4) x 6.4 - 8.6 [-9.4] ($\bar{x}$=7.6) µm, L/B=1.8, amygdaliform, finely warty rough, thick-walled, pale yellowish brown in 3% aqueous solution of potassium hydroxide. BASIDIA (20/2), 32.0 - 43.2 ($\bar{x}$=37.4) x 8.2 - 12.0 ($\bar{x}$=9.8) µm, with sterigmata up to 7.6 µm long, four-spored occasionally two-spored, clavate. CYSTIDIA not observed. UNIVERSAL VEIL glutinous, to 590 µm deep, of filamentous, loosely repent to ascending hyphae, (20/2), 2.0 - 4.2 ($\bar{x}$=3.5) µm diam. PILEAL CUTICLE a narrow band of repent, filamentous to cylindric hyphae. CLAMP CONNECTIONS present.

HABIT, HABITAT AND PHENOLOGY - solitary, gregarious or caespitose on the ground. Specimens collected in March, May and June.

MATERIAL - TASMANIA: Cheshunt, 16.iv.1856, K holotype, W. Archer. NEW SOUTH WALES: Mosman, Sydney, 20.v.1917, AD 4103. SOUTH AUSTRALIA: Mt Lofty, 25.v.1920, AD 4105; 29.iii.1924, AD 4099. Belair Recreation Park, 16.v.1931, AD 4101. Woodside, 19.vi.1946, AD 4102. Adelaide hills, v.1954, AD 4100, N. Atkinson.

This species can be distinguished from Cortinarius subarcheri Clel. and C. bundarus Grgurinovic by its large, amygdaliform spores. Cortinarius archeri constitutes the type of Section Archeriani.

6. Cortinarius microarcheri Clel. - Fig. 6 A-B

Cortinarius microarcheri Clel. in Trans. R. Soc. S. Australia 57:191, 1933.

PILEUS 18 - 62 mm diam., convex to nearly plane, edge sometimes striate, glutinous, deep violet or violet-brown, drying from the centre to earth-brown or light brown (Amber Brown, XL), flesh violet-tinted or whitish. LAMELLAE slightly sinuate to adnexed, moderately close, pallid violet to violet-brown, (Buffy Brown (XL), with violet tints), then earth-brown (Snuff Brown, XXIX). STIPE 31 - 50 mm long, rather slender, base a little thickened, fibrillose, slightly hollow or solid, pallid or pale violet.

BASIDIOSPORES (54/6), 6.4 - 8.6 ($\bar{x}$=7.1) x 4.8 - 8.3 ($\bar{x}$=5.3) µm, L/B=1.3, short ellipsoid to ellipsoid, warty rough, slightly thick-walled, yellowish brown in 3% aqueous solution of potassium hydroxide. BASIDIA (17/2), 27.2 - 41.2 ($\bar{x}$=33.7) x 6.4 - 9.6 ($\bar{x}$=8.4) µm, with sterigmata up to 6.4 µm long, four-spored, clavate. CYSTIDIA absent. UNIVERSAL VEIL to 250 µm deep, of filamentous hyphae, (11/1), 3.1 - 4.8 ($\bar{x}$=4.2) µm diam., gelatinized, lower portion of loosely ascending hyphae, upper portion of loosely repent hyphae. PILEAL CUTICLE to 96 µm deep, of repent, filamentous hyphae, (7/1), 3.6 - 5.5 ($\bar{x}$=4.8) µm diam., with plasmatic pigment. CLAMP CONNECTIONS present.

HABIT, HABITAT AND PHENOLOGY - solitary to gregarious on the ground. Specimens collected in June.

MATERIAL - SOUTH AUSTRALIA: Mt Lofty, 16.vi.1917, AD 4231 (lectotype, here designated); 19.vi.1921, AD 4219 (syntype); 23.vi.1928, AD 4224 (syntype); 8.vi.1931, AD 4222 (syntype); 8.vi.1931, AD 4223 (syntype). Eagle on the Hill, 5.vi.1932, AD 4230 (syntype). Kersbrook, 25.vi.1933, AD 4227, Dr Rogers.

The violet pileus, violet-brown lamellae, and ellipsoid spores indicate that this species belongs in Section Archeriani, Stirps Iodes (Moser & Horak, 1975:578; Singer, 1986:638).

7. Cortinarius subarcheri Clel. - Fig. 7

Cortinarius subarcheri Clel. in Trans. R. Soc. S. Australia 52:220, 1928 p.p.

PILEUS 25 - 60 mm diam., at first deeply convex then expanding to convex, occasionally with a depression in the centre, viscid, becoming shining, violet becoming brownish violet to violet (Brownish Vinaceous to Deep Brownish Vinaceous (XXXIX) with tints of Deep Purplish Vinaceous (XLIV) or Mars Brown (XV) and darker towards the edge). LAMELLAE adnate or sinuate, close, narrow, becoming slightly ventricose, violet becoming

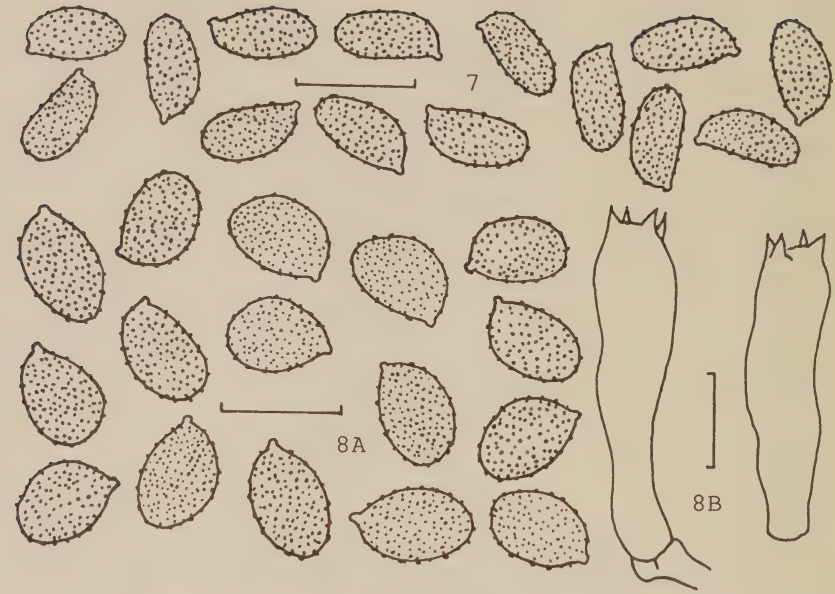

Fig. 7. *Cortinarius subarcheri*.- Basidiospores.
Fig. 8. *Cortinarius bundarus*.- A. Basidiospores.
B. Basidia. Bars = 10 µm

Vinaceous Fawn (XL), Sorghum Brown (XXXIX), Prout's Brown (XV) or Apricot Buff (XIV). STIPE 35 - 51 mm long, stout, cylindric or base slightly bulbous, root rather conical, 15 - 25 mm diam., fibrillose, solid, sticky when moist, whitish to violet (Pale Lobelia Violet, XXXVII, Grayish Lavender to Deep Grayish Lavender, XLIII). FLESH white with a faint violet tint in stipe, or paler than Grayish Lavender. VEIL white.

BASIDIOSPORES (54/4), 8.6 - 11.6 ($\bar{x}$=9.5) x 4.8 - 6.1 ($\bar{x}$=5.3) µm, L/B=1.8, elongate ellipsoid, sometimes approaching cylindric, finely warty rough, slightly thick-walled, yellowish brown in 3% aqueous solution of potassium hydroxide. BASIDIA (3/1), 34.7 - 37.6 x 7.7 - 8.7 µm, with sterigmata up to 2.4 µm long, four-spored, clavate. CYSTIDIA not observed. UNIVERSAL VEIL to 354 µm deep, of loosely arranged, filamentous, gelatinized hyphae, (10/1), 2.4 - 4.3 ($\bar{x}$=3.5) µm diam. PILEAL CUTICLE a narrow band of filamentous hyphae, with brownish pigment. CLAMP CONNECTIONS present.

HABIT, HABITAT AND PHENOLOGY - solitary, usually gregarious on the ground under Eucalyptus baxteri (Benth.) Maiden & Blakely, etc. Specimens collected in May and June.

MATERIAL - SOUTH AUSTRALIA: Mt Lofty, 16.vi.1917, AD 4220; 16.vi.1917, AD 4225; 19.vi.1920, AD 4226. Kinchina, 7.vii.1923, AD 4661. Mt Burr Forest Reserve, 30.v.1928, AD 4316 (lectotype, here designated). Morialta, 3.vi.1933, AD 4311. Willunga Hill, v.1932, AD 4313. Echunga, 12.vi.1939, AD 4662.

The violet-brown pileus and lamellae, and the elongate ellipsoid spores indicate that this species belongs in Section Archeriani, Stirps Iodes (Moser & Horak, 1975:578; Singer, 1986:638).

8. Cortinarius bundarus Grgurinovic, sp.nov. - Fig. 8 A-B

Cortinarius subarcheri Clel. in Trans. R. Soc. S. Australia 52:220, 1928 p.p.

Pileus usque ad 89 mm diametro, irregulariter convexus, violaceus deinde versus apicem pallide brunneolus. Lamellae sinuatae, moderate confertae, ex violaceo caryophyllaceo-cinnamomeae. Stipes usque ad 38 mm longus, crassus, fibrillosus, ex violaceo pallidus. Sporae 9.4 - 10.8 [-11.6] ($\bar{x}$=10.1) x 6.0 - 7.3 ($\bar{x}$=6.7) µm, ellipsoideae, verrucosae. Basidia 32.0 - 44.4 ($\bar{x}$=37.5) x 8.0 - 10.8 ($\bar{x}$=9.4) µm, clavata, 4-sporigera. Holotypus: South Australia, Bundaleer State Forest, vi.1928, AD 4329.

PILEUS up to 89 mm diam., irregularly convex, violet, becoming pale brownish in centre. LAMELLAE sinuate, slightly toothed, moderately close, Pinkish Cinnamon (XXIX) tinged with violet. STIPE up to 38 mm long, stout, to 38 mm diam., downy-fibrillose, violet-tinted. FLESH with violet or lilac tints.

BASIDIOSPORES (50/1), 9.4 - 10.8 [-11.6] ($\bar{x}$=10.1) x 6.0 - 7.3 ($\bar{x}$=6.7) µm, L/B=1.5, ellipsoid, coarsely warty rough, slightly thick-walled, yellowish brown in 3% aqueous solution of potassium hydroxide. BASIDIA (15/1), 32.0 - 44.4 ($\bar{x}$=37.5) x 8.0 - 10.8 ($\bar{x}$=9.4) µm, with sterigmata up to 4.0 µm long, four-spored, clavate. CYSTIDIA not observed. UNIVERSAL VEIL to 230 µm deep, of filamentous, gelatinized hyphae, (11/1), 1.9 - 4.3 ($\bar{x}$=3.1) µm diam., loosely repent to somewhat ascending. CLAMP CONNECTIONS present.

HABIT, HABITAT AND PHENOLOGY - gregarious on the ground. Specimen collected in June.

MATERIAL - SOUTH AUSTRALIA: Bundaleer State Forest, vi.1928, AD 4329 (holotype).

This species is distinguished from Cortinarius subarcheri by its ellipsoid and slightly larger spores. The violet pileus, violet tinged lamellae and ellipsoid spores indicate that this species belongs in Section Archeriani, Stirps Iodes, as defined in Singer (1986:638). The specific epithet is derived from the aboriginal word "bundara", meaning a "clump of trees".

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STUDIES ON *GALEROPSIS* AND *GASTROCYBE* *(BOLBITIACEAE, AGARICALES)*

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ABSTRACT

After we have studied the holotype of *Galeropsis desertorum* Velen. & Dvorak, type specimen of the genus *Galeropsis*, the presence of a hymeniform epicutis is proved contrary to the traditional interpretation as a cutis. The same happens with *G. bispora* Vasil'kov and *G. andina* Singer. The genus *Gastrocybe* Watling is considered as synonymous of *Galeropsis* Velen. We propose the following new combinations: *Galeropsis lateritia* (Watling) comb. nov., *G. deceptiva* (Baroni) comb. nov. and *G. desertorum* var. *bispora* (Vasil'kov) comb. et status nov.

INTRODUCTION

The genus *Galeropsis* Velen. was described by VELENOVSKY (1930) and in his original description the following microscopic characters were specified: "Basidiis subglobosis, quadristerigmatosis. Pulvere fusco. Sporis ovato-ellipticis, ochraceo-luteis, glabris. Cystidiis nullis.", without any reference to the structure of the epicutis.

Later on, SINGER (1963, 1986), WATLING (1968), SINGER & PONCE DE LEON (1982) and MORENO & al. (1987) considered the epicutis of *Galeropsis* as a cutis. On the other hand WATLING (1968) described the genus *Gastrocybe* with a hymeniform epicutis as the main differentiating character.

However, there are some references in the literature on the presence of a hymeniform epicutis in the genus *Galeropsis*, e.g. the comments given by Singer and compiled by HEIM (1950) in relation to *G. plantaginiformis* (Lebedeva) Singer which we reproduce he-

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re: "Le péridium est composé de deux couches, l'enveloppe extrême consiste en cellules en palissade, claviformes, brunes ou hyalines (10-11,5 µm de diam.), l'autre plus épaisse, devient vers l'intérieur une couche de jonction orientée transversalement, généralement plus dense vers l'intérieur".

WASSER (1979) described the following: "Epicutis of the cap consists of brownish and colourless cells (17-22 x 5-10 µm) and globate hyphae (10-12 µm diam.). Dermatocystidi absent".

The studies on the epicutis, very important in the differentiation of these genera, have not been mentioned neither in the studied species by HEIM (1950), nor in the following taxa described as new to science: *Galeropsis allospora* Singer, *G. angusticeps* (Peck) Singer, *G. liberata* (Kalchbr.) Heim, *G. madagascariensis* Singer and *G. mitraeformis* (Berk.) Heim.

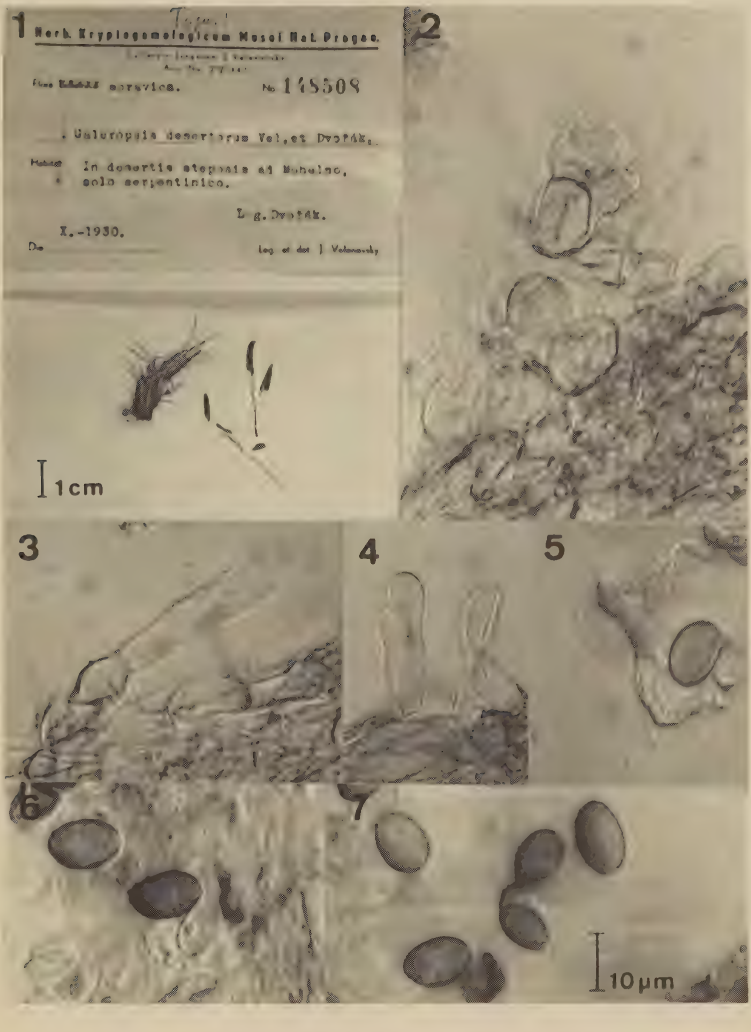
However SINGER (1963), when he described *Galeropsis andina* Singer, pointed out: "epicutis of the peridium not gelatinized, of elongated hyphae which forms a cutis", which makes us think on the possible existence of taxa without a hymeniform structure in their epicutis, conclusion which is wrong, as we will show further on (the revision of *G. andina* has proven that this species has a hymeniform epicutis).

The presence of pileocystidia has not been described for *Galeropsis desertorum*, *G. plantaginiformis* and *G. bispora*. However, they have been confirmed in *Gastrocybe iberica* (MORENO & al., 1987).

Material examined: *Galeropsis desertorum* (holotypus) PR 148508; *Galeropsis bispora* (isotypus) PR 678864; *Galeropsis plantaginiformis* (isotypus) PR 678867; *Galeropsis desertorum* var. *bispora* (as *G. desertorum*), on roots of *Poa bulbosa*, Iran (Kabus), leg. T.F. Hewes, MA-Fungi 16932. *Galeropsis andina* Singer (isotypus) BAFC 31514.

Conclusions: We think that *Galeropsis desertorum* Velen. & Dvorak (Figs. 1-7), type specimen of the genus *Galeropsis* Velen., is very variable in the size of its carpophores and the measurements of its spores; this species presents lageniform pileocystidia (sometimes difficult to observe if the material has been badly dried or colapssed), and a hymeniform epicutis formed by a single layer of cells instead of a cutis as traditionally was thought. The latter makes that we believe the genus *Galeropsis* must be emended and, besides, that the genus *Gastrocybe* is synonymous of *Galeropsis* and therefore its described species have to be transferred to the genus *Galeropsis*.

The bisporic species *Galeropsis bispora* Vasil'kov (Figs. 16-24) and *G. plantaginiformis* (Lebedeva) Singer (Figs. 8-15) have also been revised, and it turns out that we consider *G. bispora* as a bisporic variety of *G.*



Herb. Kryptogamologicum Musei Nat. Pragae.

[illegible] servica. No 148508

Galeropsis desertorum Vel. et Dvořák.

In desertis [illegible] ad [illegible],
solo serpentinico.

Leg. Dvořák.

X.-1930.

Leg. et det. J. Velenovský

Figs. 1-7. *Galeropsis desertorum*. Basidiocarps, epicutis, pileocystidia and spores. (Holotypus, PR 148508) *desertorum*, being the main character to differentiate it the constancy of its bisporic basidia, without having observed any tetrasporic. On the other hand, the fact it has spores with a bigger size than *G. desertorum* is logical in a bisporic variety. The epicutis and the presence of pileocystidia are similar to those of *G. desertorum*, and they were not described up to date.

The species *Gastrocybe iberica* Moreno, Illana & Heykoop (Figs. 25-29) is considered by us as synonymous of *Galeropsis bispora* (vide comparative table).

The typus of *Galeropsis plantaginiformis* presents tetrasporic basidia and very uncommonly some bisporic. The morphology of the spores (spore wall, germ pore) and the measurements are similar to those of *G. desertorum*, therefore both species are considered as synonymous by us as well as did PILAT (1948) and VASIL'KOV (1954), contrary to the opinion of SINGER (1936, 1951, 1956), HEIM (1950) and KOTLABA & POUZAR (1959).

After studying an isotypus of *Galeropsis andina* we have observed that it presents a hymeniform epicutis (Figs. 30-35), formed by a single layer of cells, and not a cutis as pointed out by SINGER (1963). The morphology of the spores and basidia agree with the description given by this author.

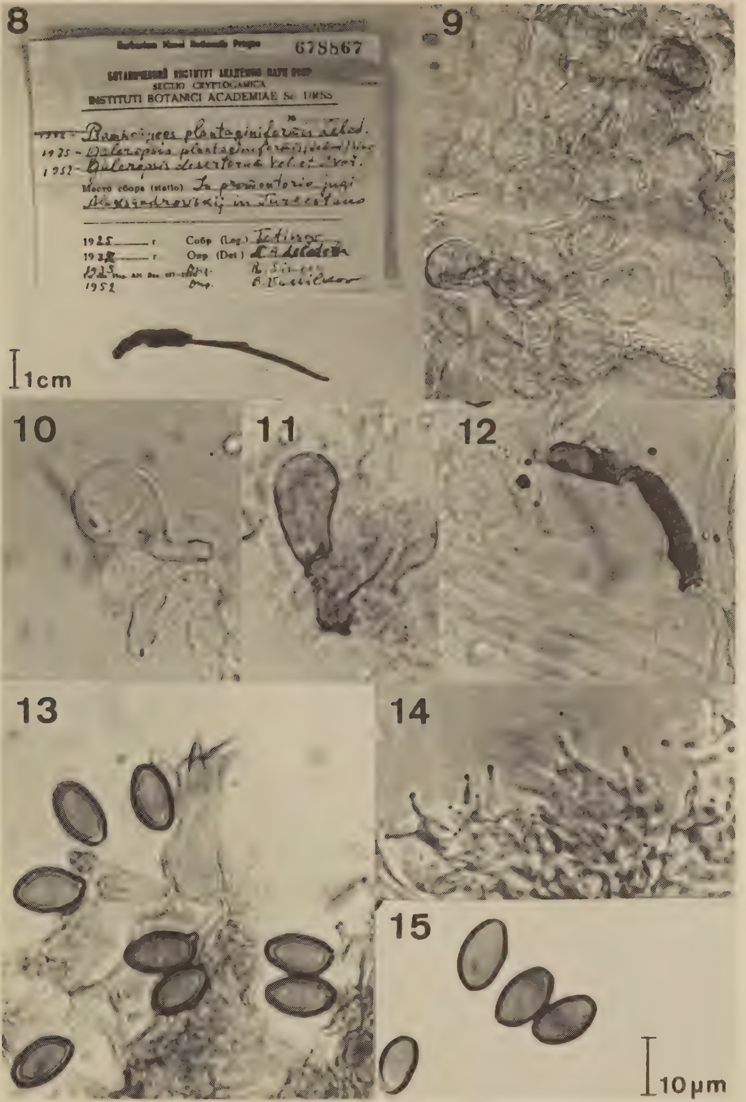
GALEROPSIS Velenovsky, Mykologia, Praha 7:105 (1930.
= ***GASTROCYBE*** Watling, The Michigan Botanist 7:20 (1968).
= ***PSAMMOMYCES*** Lebedeva, Tr. Zasc. Rast. 5(1):116 (1932).
= ***CYTTAROPHYLLUM*** (Heim) Singer, Beih. bot. Cbl. 56/B:147 (1936).

Galeropsis lateritia (Watling) Moreno, Heykoop & Illana comb. nov.
≡ ***Gastrocybe lateritia*** Watling, The Michigan Botanist 7:20 (1968).

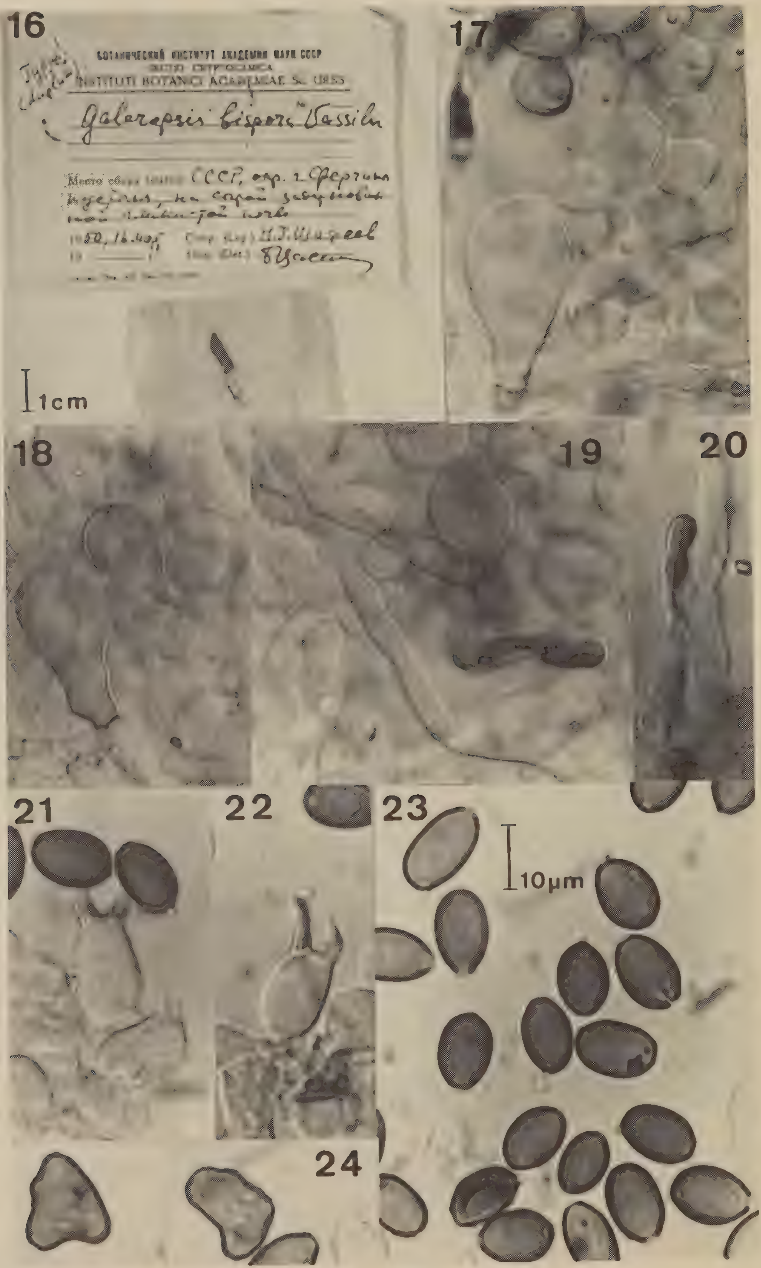
Galeropsis deceptiva (Baroni) Moreno, Heykoop & Illana comb. nov.
≡ ***Gastrocybe deceptiva*** Baroni, Mycologia 73:181-182 (1981).

Galeropsis desertorum Velen. & Dvorak var. bispora (Vasil'kov) Moreno, Heykoop & Illana comb. et status nov.
≡ ***Galeropsis bispora*** Vasil'kov, Proc. Bot. Inst. Acad. Sci. USSR, ser. 2. 9:463 (1954).
= ***Gastrocybe iberica*** Moreno, Illana & Heykoop, Cryptogamie, Mycol. 8:323-324 (1987).

On the following table we compare the epicutis, basidia and basidiospores of *Galeropsis desertorum* Velen. & Dvorak, *G. plantaginiformis* (Lebedeva) Singer, *G. bispora* Vasil'kov and *Gastrocybe iberica* Moreno, Illana & Heykoop.


8
SECTIO CRYPTOGAMICA
INSTITUTI BOTANICI ACADEMIAE Sc. URSS
Место сбора (statio)
Собр. (Leg.)
Опр. (Det.)
1cm
9
10
11
12
13
14
15
10 µm

Figs. 8-15. *Galeropsis plantaginiformis*. Basidiocarp, epicutis, pileocystidium, basidia and spores. (Isotypus, PR 678867).


16
17
1cm
18
19
20
21
22
23
10µm
24

БОТАНИЧЕСКИЙ ИНСТИТУТ АКАДЕМИИ НАУК СССР

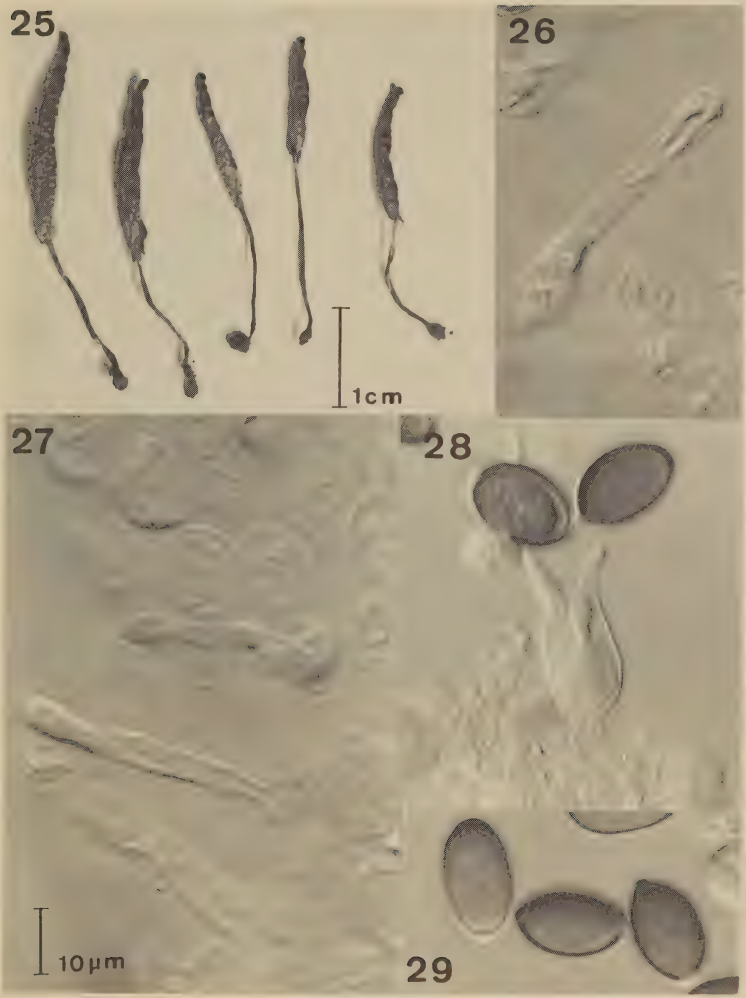
INSTITUTI BOTANICI ACADEMIAE Sc. URSS

Galeropsis bispora Vassilk.

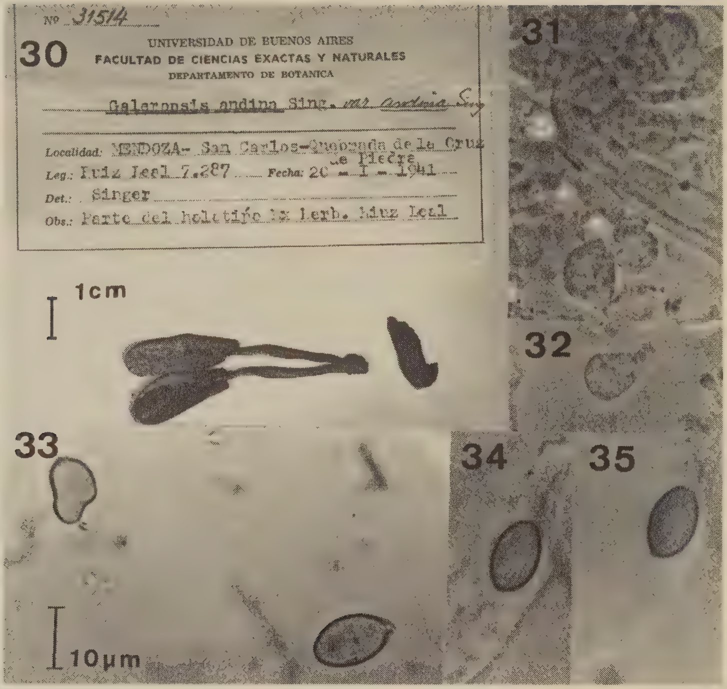
Место сбора [illegible] СССР, окр. г. Ферганы [illegible]

1950, 16.IV

Figs. 16-24. *Galeropsis bispora*. Basidiocarp, epicutis, pileocystidia, basidia and spores. (Isotypus, PR 678864).


25
26
1cm
27
28
10µm
29

Figs. 25-29. *Gastrocybe iberica*. Basidiocarps, epicutis, pileocystidia, basidium and spores. (Holotypus, H.AH 9990).



Nº 31514

UNIVERSIDAD DE BUENOS AIRES
FACULTAD DE CIENCIAS EXACTAS Y NATURALES
DEPARTAMENTO DE BOTANICA

Galeropsis andina Sing. var. andina Sing.

Localidad: MENDOZA- San Carlos-Quebrada de la Cruz de Piedra
Leg.: Ruiz Leal 7.287 Fecha: 20 - I - 1941
Det.: Singer
Obs.: Parte del holotipo ex Herb. Ruiz Leal

Figs. 30-35. *Galeropsis andina*. Basidiocarps, epicutis and spores. (Isotypus, BAFC 31514).

Galeropsis desertorum

Epicutis
Hymeniform with lageniform pileocystidia

Basidia
Tetrasporic

Spores
11-14 x 7-8 µm (KOTLABA & POUZAR, 1959)

Galeropsis plantaginiformis

Epicutis
Hymeniform with lageniform pileocystidia

Basidia
Bisporic (SINGER, 1963)
tetrasporic predominate (personal revision)

Spores
10-12,5 x 5,5-8,3 µm (HEIM, 1950)
9-12,5 x 5,5-7,2 µm (KOTLABA & POUZAR, 1959)
10,5-13 x 6-7,5 µm (personal revision)

Galeropsis bispora

Epicutis
Hymeniform with lageniform pileocystidia

Basidia
bisporic

Spores
14-16 x 10-11 µm (KOTLABA & POUZAR, 1959)
12,8-15(17,5) x 7,5-9,8 (10,5) µm (personal revision)

Gastrocybe iberica

Epicutis
Hymeniform with lageniform pileocystidia

Basidia
bisporic

Spores
15-20(23) X 9-13(18) µm MORENO & al., 1987)

ACKNOWLEDGMENTS

We wish to express our gratitude, for supplying us with references, to Dr. V. Antonín, Dr. R. Singer, Dr. A. Raitviir and Dr. R. Watling. We are also very grateful to Dr. M. Svrček for the loan of the types of Velenovsky and Vasil'kov which are kept in PR, and to Dr. J. E. Wright for the loan of an isotype of *Galeropsis andina* which is kept in BAFC.

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PHYTOPHTHORA ERYTHROSEPTICA

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ABSTRACT

Phytophthora erythroseptica was established by Pethybridge in 1913 as the fungus causing pink rot of potato tubers. It was characterized by formation of nonpapillate sporangia in water and the production in single cultures of abundant relatively large oogonia with amphigynous antheridia. Recently, several authors questioned the species concept of P. erythroseptica by including isolates that produced both amphigynous and paragynous antheridia. The present study was undertaken to compare 14 isolates of P. erythroseptica from various parts of the world in order to re-define the species based on morphological and cultural characteristics. It was concluded that isolates producing paragynous antheridia should not be assigned to P. erythroseptica.

INTRODUCTION

Phytophthora erythroseptica Pethyb. was named by Pethybridge (1913) as the incitant of pink rot of potato tubers. It was characterized by the formation in water of "conidia.....more or less ovate or inversely pear-shaped, with a rather blunt or even somewhat flattened apex" and the production in single culture of abundant sex organs so that "the oogonial incept enters the antheridium at or near its bases, grows up through it and out at the top, expanding there to form the oogonium proper in which the oospore develops". This unique method of sexual reproduction in P. erythroseptica was confirmed by Murphy (1918) who described the antheridium as "amphigynous" in contrast to the "paragy-nous antheridium which grew up to the side of the oogonium".

Since the erection of P. erythroseptica, three varieties have been proposed: var. atropa on Atropa belladonna (Alcock, 1926), var. pisi on pea (Bywater & Hickman, 1959) and var. drechsleri as a new combination for P. drechsleri Tucker (Sarejanni, 1936). They were all rejected by Waterhouse (1963) who considered var. atropa not significantly different from var. erythroseptica and var. drechsleri synonymous with P. drechsleri which she retained and var. pisi, invalidly published for failing to cite the type specimen. But she retained var. pisi in her key and considered P. himalayensis (Dastur, 1948) identical to P. erythroseptica. Regardless of their taxonomic status, members of these taxa had one character in common: the production of entirely amphigynous antheridia.

However, Cooper (1928) studied the type culture of P. erythroseptica and found no amphigynous antheridia. Instead, he found paragynous antheridia closely appressed at the base of the oogonia. Converse and Schwartz (1968) identified the causal agent of root rot of red raspberry as P. erythroseptica sensu lato even though paragynous antheridia were produced in addition to the abundant amphigynous antheridia. Savage et al. (1968) also found that some isolates of P. erythroseptica produced paragynous antheridia and amphigynous antheridia in varying proportions. They pointed out the similarity between P. erythroseptica and P. megasperma Drechs. in producing nonpapillate sporangia and both antheridial types in single cultures as well as pathogenicity to potato tubers. Recently, Pratt (1981) identified some fast growing isolates from arrowleaf clover tentatively as P. erythroseptica although the antheridia were predominantly paragynous in agar but mostly amphigynous in broth cultures. He also questioned the distinction between P. erythroseptica and P. megasperma based on the antheridial type. Thus, Erwin (1983) listed P. erythroseptica as one of the few species of Phytophthora where particular nomenclature problems exist requiring critical re-evaluation.

The present study was undertaken to compare colony morphology and culture characteristics of a wide variety of isolates of P.erythroseptica under uniform conditions in order to define the species more precisely.

MATERIALS AND METHODS

Isolates and media: Specific information on the isolates of P. erythroseptica used is given in Table 1. All isolates were obtained from the American Type Culture Collection (ATCC), Rockville, Maryland. Unless otherwise stated, clarified V-8 juice agar medium (Ribeiro, 1978) supplemented with sitosterol (30 mg/l) (CV8) was used for culture.

Morphology: Colony characteristics on CV8 were compared after incubating the cultures in darkness at 20C

Table 1. Sources of *Phytophthora erythroseptica* isolates

ATCC	Host	Origin	Source
10923(a)	Unknown	USA	Jeffers
10924	Potato	Unknown	Jeffers
16698	Unknown	USA	Gallegly N65
16699(T*)	Potato	India	Gallegly N117=CMI 17028
28766	Potato	Scotland	Pitt 38
36302	Potato	USA	Rowe 100
46725	Potato	Tasmania	Zentmyer P340
53014(T)	Potato	Ireland	Ho H14.1 = CMI 34684
64047	Wild rice	USA	Ho H14.12 Gunnell
64127	Unknown	Unknown	CBS 233.30
64128	Tulipa	Unknown	CBS 380.61
64155	Unknown	United Kingdom	CMI 146453
64156	Potato	United Kingdom	CMI 181716
64861	Potato	United Kingdom	UCR P3513

(a) Received as P. drechsleri
(T*) Type of P. himalayensis
(T) Type Culture

ATCC -- identified by American Type Culture Collection accession number
CMI -- Commonwealth Mycological Institute, Kew, Surrey, England
UCR -- University of California, Riverside

for 7 days. The colony diameters were measured at right angles through the inoculum, and the width of primary hyphae measured using a light microscope. The minimal and maximal temperatures for growth were tested by growing the isolates at 5 C and 35 C. Sporangia formation was induced by incubating small mycelial agar discs on CV8 in freshly collected stream water that had been filtered through 0.45 μm pore size membrane discs and incubating the produced discs under light at 20 C. Sex organs in single cultures were examined periodically by microscopy through the bottom of the petri dish. If the isolate failed to produce sex organs in single culture, it was paired with the appropriate mating types of P. *nicotianae* (ATCC 38606, A_2 and ATCC 38607, A_1). In case of a successful mating, the ability of the isolate to produce sex organs by selfing was confirmed by pairing it with the compatible strain across a polycarbonate membrane to prevent physical contact between the cultures (Ko, 1978). They were examined for sex organs after 2-3 wk incubation in the dark at 20 C. If these attempts failed to induce formation of sex organs, the isolate was grown on tryptophan medium (Ribeiro, 1978) and sterilized oat grains (Van der Zwet & Forbes, 1961) and examined after 4-5 months.

RESULTS

Colony morphology

Isolates of P. erythroseptica grew well on CV8 (4-8 mm/day at 20 C) forming uniform, non-fluffy to moderately fluffy colonies with a diffuse and slightly irregular outline and no special growth pattern. ATCC 64047 colonies were distinctly fluffy with tall, erect aerial hyphae almost reaching the cover of the petri plate. ATCC 16699 colony radial growth was exceptionally slow (2mm/day), whereas ATCC 58104 grew faster than the others (11 mm/day). No isolates grew at 35 C, while some grew at 5 C (Table 2). The leading hyphae were uniform and fine, measuring 5-6 μm wide. In most isolates, small spherical to angular swellings in clusters or in chains were produced when mycelial agar discs were transferred to water although ATCC 46725 produced them also in old cultures.

Sporangia

All isolates produced sporangia readily in water within 24-48 hr, except ATCC 16698 and ATCC 64861 which formed them sparsely only in non-sterile stream water. The sporangia were non-deciduous, non-papillate and borne terminally on short sympodial branches of a slender sporangiophore. They were mostly 40-55 x 25-30 μm (Table 2), obpyriform to ovoid with rounded base although elongated ellipsoidal sporangia with tapering bases were also found, especially in ATCC 36302, ATCC 46725 and ATCC 58104. ATCC 64047 produced distinctly larger sporangia (68±11 x 35±7 μm). The apex of the sporangium in all isolates flattened easily when prepared for microscopy, and the empty sporangium partially collapsed after oospore release. The base of the sporangium was often plugged, and the ability of sporangia to proliferate internally varied with the isolate. Internal proliferation of sporangia was rare in ATCC 16699, ATCC 28766, ATCC 36302, ATCC 46725 and ATCC 58104 and occurred mostly in nonsterile stream water only, but it was commonly found in ATCC 16698 and especially ATCC 64047. Repeated emergence of zoospores was observed only in ATCC 46725.

Sex organs

Most isolates of P. erythroseptica produced abundant

Table 2. Growth and sporangial characteristics of *Phytophthora erythroseptica*

ATCC	Colony	Growth at 5 C	Growth at 35 C	Hyphal Swellings(a)	Sporangium Length(L) (μm)	Sporangium Breadth(B (μm)	Sporangium L/B	Sporangium Median Constriction	Sporangium Flat apex	Sporangium Internal proliferation
10923	MF	+/-	--	+	48+6(b)	31+4	1.6+0.2	+/-	+/-	+/-
10924	MF	--	--	+	47+8	26+4	1.8+0.3	+/-	+	+/-
16698	MF	--	--	+	47+5	28+3	1.7+0.1	--	--	+/-
16699	MF	--	--	+	38+5(c)	23+3	1.7+0.3	--	--	--
28766	SF	--	--	+/-	54+6	31+5	1.8+0.3	--	+/-	+/-
36302	SF	--	--	+	56+7	28+3	2.0+0.1	+/-	+/-	+/-
46725	SF	+	--	+	49+7	27+5	2.0+0.4	+	+	+/-
58104	SF	+	--	+	42+8	24+3	1.8+0.4	+	+	+/-
64047	F	--	--	+/-	68+11	35+7	2.0+0.5	+/-	+	+
64127	NF	+	--	-	48+6	30+3	1.6+0.2	--	+/-	--
64128	MF	+/-	--	-	51+6	30+4	1.7+0.2	--	+/-	--
64155	NF	+	--	-	41+5	26+3	1.6+0.1	+/-	+/-	+/-
64156	NF	+	--	-	47+3	31+2	1.5+0.1	+/-	+/-	+/-
64861	NF	-	--	+	39+7	24+3	1.6+0.2	+	+	--

(a) Small, angular, clustered or in chain

(b) Mean + standard error, based on 50 measurements

(c) Less than 50 measurements due to paucity of sporangia sex organs readily either in water immediately following sporangial production or in single cultures on agar plates in 2-3 wk. The spherical oogonia were rather large, mostly 35-40 µm diam (Table 3), narrowing abruptly to a tubular stalk and were non-pigmented, although they eventually became faintly yellow or straw-colored with age. The oospores were aplerotic to markedly aplerotic with oospore wall 2-4 µm thick. The antheridium was unicellular, amphigynous and cylindrical. Occasionally, structures resembling paragynous antheridia, as described by Ho *et al*. (1983), were found in addition to the amphigynous antheridium. The dimensions of the sex organs are summarized in Table 3.

Table 3. Dimensions of sex organs of *Phytophthora erythroseptica*

				Antheridium		
ATCC	Oogonium diameter(µm)	Oospore diameter(µm)	Free oogonial space (a)	Type	Length(µm)	Width(µm)
10923	34±3 (b)	28±3	32%	A	14±2	13±2
10924	37±4	31±3	30%	A	11±2(b)	12±1
16698	40±3	31±5	40%	A	12±2	16±1
16699	No sex organs					
28766	38±2	32±2	29%	A	12±2	12±2
36302	38±3	32±3	29%	A	12±2	13±1
46725	38±3	31±3	33%	A	14±3	13±2
58104	No sex organs produced in single culture					
64047	41±1	31±4	43%	A	17±3	14±2
64127	37±3	31±3	30%	A	12±2	12±2
64128	37±2	30±2	34%	A	13±2	12±1
64155	34±4	27±3	37%	A	11±2	13±1
64156	37±2	31±2	30%	A	12±2	12±1
64861	No sex organs produced in single cell					

(a) $$\text{Free oogonial space} = \frac{\text{Oogonium diam} - \text{oospore diam X } 100}{\text{Oogonium diam}}$$

(b) Mean + standard error, based on 50 measurements

A = Amphigynous

ATCC 46725 produced sex organs only in old cultures or on oat grains, whereas ATCC 16699 never produced sex organs. Sex organs were produced by ATCC 10924 only once in water but were consistently induced by pairing it with A1 mating types of *P. nicotianae* and other heterothallic species of *Phytophthora* (Table 4). Similarly, ATCC 58104 never produced sex organs in single cultures but produced them readily when crossed with an A2 mating type of *P. nicotianae* and other heterothallic species. None of the other isolates of *P. erythroseptica* demonstrated heterothallic behavior. However, the oogonia of ATCC 10924 and ATCC 58104 formed heterothallically by selfing on membranes were smaller, mostly 29-33 µm diam and pigmented (brown), different from those normally formed in single cultures.

Table 4. Production of sex organs in crosses between ATCC 10924 and ATCC 58104 Phytophthora erythroseptica and other species of Phytophthora

			P. erythroseptica	
Name	ATCC	Mating Type	ATCC 10924	ATCC 58104
P. cinnamomi	32992	A2	---	+++
	32993	A1	+++	---
P. cryptogea	46721	A1	+++	---
	52403	A2	---	+++
P. nicotianae	38606	A2	---	+++
	38607	A1	+++	---
P. palmivora	26200	A2	---	+++
	26201	A1	+++	---
P. erythroseptica	10924		---	+++
	58104		+++	---

Chlamydospores

No chlamydospores was produced by any isolate of P. erythroseptica under the stated cultural conditions.

DISCUSSION

Phytophthora erythroseptica is well known as the causal agent of pink rot of potato tubers throughout the world (Hickman, 1958; Stamps, 1978) although it has minor hosts in belladonna (Alcock, 1926), tulip (Buddin, 1938), calla (Tompkins & Tucker, 1947,1950), sugarcane (Steib & Chilton, 1950; Singh, 1955), onion (Hickman, 1958), pea (Bywater & Hickman, 1959), tomato (Walker & McLeod, 1970), cineraria (Lucas, 1977), and calceolaria (anonymous, 1980). The disease in potato is characterized by formation of a deep salmon-pink coloration when affected tissue is exposed to the air due to a tyrosinase reaction (White, 1946) and was initially considered as a diagnostic symptom. It was later found that similar or identical symptoms could be induced by other species of Phytophthora by artificial inoculation, and in nature P. megasperma, P. cryptogea and P. drechsleri were also isolated from diseased potato (Tucker, 1931; Carnes & Muskett, 1933; Goss, 1949; Rowe & Schmitthenner, 1977). Thus, the precise identification of P. erythroseptica is critical to identification of the pathogen that causes pink rot of potato in the field. However, there have been controversies over the species concept of the pathogen. For the sake of discussion, the published data on P. erythroseptica are summarized in Table 5.

Table 5. Characteristics of Phytophthora erythroseptica recorded in literature chronologically

Ref.	Host	Growth Temperature Min. (C)	Growth Temperature Max. (C)	Hyphal swellings	Sporangium Length(µm)	Sporangium Breadth(µm)	L/B	Oogonium diam(µm)	Oospore diam(µm)	Oospore Wall	Antheridium Type	Antheridium Length (µm)	Antheridium Width (µm)
41	Potato				32	20	1.6				A		
46					45	28	1.6		36		A		
64	Atropa				44	26	1.7	38	33		A		
1	Atropa				48	30	1.6		29-32		A		
56	Potato	15	30					36	31		A		
8	Potato								30		A		
									32		A		
									31		A		
									32		A		
									32		A		
									33		A		
									32		A		
									32		A		
									31		A		
									31		A		
									31		A		
									32				
	Atropa(a)								33		A		
32									31				
5	Tulip				49	30	1.6	30-37	25-29	3	A		
27	Potato	4.8	34								A		
54	Pink calla	13	28		35	21	1.7	36	29	3-4	A	12-19	12-19
55	White calla				35	20	1.8						
12	Potato(b)			+	29-50	22-36		35	31	2-3	A		
37	Potato(b)				32	20	1.6	33-34	29-30		A		
28	Potato								29-32		A		
51	Sugarcane	8	28	+	61	37	1.6	47					
6		5	35		52	30	1.7	33	26	2.5	A	15	14
		5	35		57	31	1.8	34	26	2.0	A	12	12
		5	35		42	31	1.4	36	27	3.0	A	12	13
		5	35		48	26	1.8	No sex organ produced					

Table 5. (continued)

		Growth Temperature			Sporangiuum			Oogonium	Oospore		Antheridium		
Ref.	Host	Min. (C)	Max. (C)	Hyphal swellings	Length(µm)	Breadth(µm)	L/B	diam(µm)	diam(µm)	Wall	Type	Length (µm)	Width (µm)
	Potato(b)	5	35		53	33	1.6	30	30	3.1		14	12
7	Pea(c)	12	30		86	35	2.5	37	26		A	19	18
					63	29	2.1						
50		5	35						29		A		
57	Potato		35										
62		2.5	34	+	43	26	1.7	30-35			A	14	13
30	Potato		33	+	38	31	1.5	43-48			A	14	13
14	Potato	2.5	33	+	41	29	1.4	35	28		A	15	14
					48	30	1.5						
					51	31	1.6						
58	Potato		34		42	26	1.6	36	31		A	13	13
			34		42	27	1.5	35	31		A	14	12
			34		43	27	1.6	35	31		A	15	13
			34		43	27	1.6	35	30		A	15	13
			34		46	26	1.7	35	31		A	15	13
			32-34		37	26	1.5	35	28		A	13	13
			34		43	26	1.6	35	31		A	15	13
			30-32		42	28	1.5	34	24		A	13	12
			34		43	27	1.6	42	34		A	17	16
40					32	20	1.4-1.6		29-30		A	11-20	10-18
47	Potato		35	+	45-50						A	15	
34	Cineraria				44	27	1.6	35			A	13-14	
52		2.5	34	+	43	26	1.7	30-35			A	14	13
39								28-50	20-35		A	cylindrical	
26	Tomato	8-15	30		28-65	18-38		20-40			A	15-17	
18	Potato		34	+	44	31	1.4	42	39		A	16	12
31	Potato	2	32-35	+	46	30	1.6	37	32	1.5-4	A		
9	Potato				Elliptical						A	Elongated	
20	Wild rice	9	36		64	37	1.8	41	33		A	15	15
35		5-10	30-35										

(a) P. erythroseptica var. atropa (b) P. himalayensis = (P. erythroseptica) (c) P. erythroseptica var. pisi A= Amphigynous

Our study confirmed the findings of previous workers concerning the cultural and hyphal characteristics of *P*. *erythroseptica*. Isolates of *P*. *erythroseptica* grew well on common agar media, producing non-fluffy to fluffy colonies with uniform and fine hyphae. ATCC 16699 which grew exceptionally slow, showed signs of degeneration probably as a result of long-term storage. In literature, *P*. *erythroseptica* var. *pisi* was unusual in having irregular, tortuous hyphae, whereas the luxuriant, tall aerial mycelium of ATCC 64047 in the present study distinguished itself from the other isolates. Small angular to spherical hyphal swellings, in clusters or in chains, as reported earlier by some researchers, were also produced by some isolates in the present study, usually in water culture. Chlamydospores were never observed. Previous authors also failed to record chlamydospores in *P*. *erythroseptica* although Ershad (1971) and Krober (1985) reported chlamydospores, whereas hyaline spherical structures were interpreted as "poorly differentiated chlamydospores" by Tompkins & Tucker (1947) or "chlamydospore-like bodies" by Novotelnova (1974). As noted by previous workers, no isolates of *P*. *erythrospetica* grew at 35 C. The sole report of good growth at 35 C by *P*. *erythroseptica* (Van der Zwet & Forbes, 1961) needs to be confirmed. Tucker (1931) considered the rather narrow temperature range (15-30 C) a diagnostic character of *P*. *erythroseptica*, but this could neither be confirmed in the present study nor by most authors in the literature.

In the species description of *P*. *erythroseptica* by Waterhouse (1963) and Stamps (1978), the sporangia were described as variable in shape, ellipsoid or obpyriform (43 - 26 μm; L/B=1.65), often constricted near the middle, sometimes tapering to the sporangiophore. In our study, the overall mean length(L) and breadth(B) of the sporangia for all isolates were 48 ± 7 x 28 ± 3 μm with L/B=1.7 ± 0.2, agreeing well with those reported in literature (46 ± x 28 ± 4 μm; L/B=1.6 ± 0.2). ATCC 64047 produced distinctly larger sporangia that were similar to those reported for *P*. *erythroseptica* var. *pisi* although not as narrow. Median constrictions of sporangia were not mentioned in the original description (Pethybridge, 1913) and have been reported to occur only occasionally by Bywater & Hickman (1959) and Vargus & Nielson (1972). They were observed in some isolates in the present study, and were especially common in ATCC 46725 and ATCC 58104 which produced mostly elongated sporangia with tapering bases. The elongated sporangia of the type culture (ATCC 58104) differed from the obpyriform sporangia diagramed by Pethybridge (1913) for *P*. *erythroseptica*. It is not clear if the type culture has undergone changes accounting for the difference which could conceivably be due to different culture conditions. Similarly, ATCC 16699, the sporangia of the type culture of *P*. *himalayensis* (=*P*. *erythroseptica*) were oval to ellipsoidal instead of "slipper-shaped" as described by Dastur initially (1948). The broad apex of sporangium of *P. himalayensis* could be due to its flattening upon mounting.

As reported previously, the sporangiophore of *P. erythroseptica* showed distinct sympodial branching, but we found that in most cases, the branching was close rather than "lax" (Waterhouse, 1963), and our observation seemed to agree with those of other authors based on their diagrams and/or photographs. Waterhouse & Blackwell (1954), Hickman (1940) and Waterhouse (1963) stated that internal proliferation of sporangia was rare in *P. erythroseptica*, whereas Gerrettson-Cornell (1981) failed to observe it in an Australian isolate from potato. In our study, the ability of the sporangium to proliferate internally varied with the isolate but was usually not as common as in other related species of *Phytophthora* with non-papillate sporangia. Many sporangia were plugged at the base after zoospore release. In fact, the sporangia of most isolates of *P. erythroseptica*, did not release zoospores easily unless the sporangia were chilled (Vujicic & Colhoun, 1966). Pethybridge (1931, 1914) experienced difficulty in inducing zoospore release in *P. erythroseptica*, whereas Dastur (1948) reported that the sporangia of *P. himalayensis* (=*P. erythroseptica*) germinated only "conidially". Neither of them noted internal proliferation of sporangia.

We have also confirmed previous observations that *P. erythroseptica* produces readily in single culture abundant rather large, smooth spherical oogonia narrowing abruptly to a tubular stalk. Apparently, some isolates of *P. erythroseptica* have lost their self-fertility due to prolonged storage and/or repeated subcultures. It is interesting to note that ATCC 10924 and ATCC 58104 behaved heterothallically instead, mating successfully with A_1 and A_2 mating types, respectively, of various *Phytophthora* species. This may be considered a case of "secondary heterothallism" derived from a homothallic precursor, lending support to the hypothesis that heterothallism probably evolved from homothallism (Brasier, 1983; Ho, 1986). Heterothallic isolates of normally homothallic *P. megasperma* have also been reported (Barr, 1980). However, the oogonia formed by ATCC 10924 and ATCC 58104 as a result of selfing on membranes when crossed with the appropriate mating strain of *Phytophthora* were smaller and brown in color, different from the larger, usually non-pigmented to pale yellow oogonia formed in single cultures of *P. erythroseptica*. It is difficult to assess the differences in oogonia characteristics without knowing the changes that have occurred during storage; the heterothallic behavior should not be considered typical for the species. ATCC 16698 never produced any sex organs alone or in pair cultures. The loss of sexuality by isolates of *P. erythroseptica* in artificial culture was noted by Bywater (1956), Carnes & Muskett (1933) and

Ribeiro *et al*. (1975). Waterhouse (1963) and Stamps (1978) described the oospores of *P*. *erythroseptica* as "nearly filling oogonium", but we found that the oospores in most isolates largely aplerotic. The overall mean values of oogonial diameters and oospore diameters for all isolates in our study were 37 ± 2 and 34 ± 4 μm, respectively, agreeing well with those in the literature (39 ± 3 and 34 ± 5 μm, respectively).

We are also in agreement with those authors who believed that *P*. *erythroseptica* produces solely amphigynous antheridia (Hickman, 1958; Tucker, 1931; Waterhouse & Blackwell, 1954; Waterhouse, 1963; Stamps, 1978; Gerrettson-Cornell, 1985). The brief report by Cooper (1928) that *P*. *erythroseptica* produced only paragynous instead of amphigynous antheridia should be questioned. It is also our opinion that *Phytophthora* species identified as *P*. *erythroseptica* in the past producing both amphigynous and paragynous antheridia should be reclassified because the identification was either debatable or provisional. Thus, the causal agent of root rot of red raspberry was identified as *P*. *erythroseptica* by Converse & Schwartz (1968), *P*. *megasperma* by Duncan *et al*. (1987) and *P*. *fragariae* by Wilcox (1989). Pratt (1981) identified some fast growing isolates from arrowleaf clover tentatively as *P*. *erythroseptica*, but a thorough search of the literature and a comparative cultural study under similar conditions showed that these isolates are within the range of intraspecific variability for *P*. *megasperma* and could be identified as such (Ho, unpublished). Morgan & Johnson (1965) identified the pathogen from vetch as *P*. *erythroseptica* because it produced only amphigynous antheridia. However, paragynous antheridia were later found in their isolate (Savage *et al*., 1968), and it should be re-classified as *P*. *megasperma* which it resembled closely based on the published photographs. There is no doubt that the antheridial type, along with the sporangial papillation, is the most important taxonomic criterion in *Phytophthora* (Tucker, 1931; Waterhouse, 1983; Gerrettson-Cornell 1985). It would be unwise to cloud the species concept of *P*. *erythroseptica* by including controversial isolates that produce both amphigynous and paragynous antheridia (Savage *et al*., 1968; Pratt, 1981). Gerrettson-Cornell (1985) considered the occasional presence of two or three antheridia (amphigynous) to a single oogonium a characteristic feature of *P*. *erythroseptica* but we could not confirm this observation in present study.

Since Pethybridge erected *P*. *erythroseptica* as a new species (1913) Leonian & Geer (1929) suggested combining *P*. *erythroseptica* and *mexicana* Hotson & Hartge, but this was promptly rejected by Tucker (1931). Bywater & Hickman (1959) proposed that *P*. *cryptogea*, *P*. *drechsleri*, *P*. *erythroseptica*, *P*. *himalayensis* and *P*. *richardiae* Buis should be grouped together as one species: *P*. *erythroseptica*. Although we agree with Bywater (1956) that these species have much in common especially in growth-temperature relations and sporangial characteristics, *P*. *richardiae* seems distinct enough to be retained as a separate species (Ho, unpublished), whereas *P*. *cryptogea* (*P*. *drechsleri*) can be differentiated based on its heterothallism and usually smaller, brown oogonia with plerotic oospores. The merging of *P*. *drechsleri* with *P*. *cryptogea*, which has priority, is favored by many workers (Ho & Jong, 1986). Sarejanni (1936) treated *P*. *drechsleri* as *P*. *erythroseptica* var. *drechsleri*, but it was not well received. *P*. *himalayensis* should be treated as synonymous with *P*. *erythroseptica* as suggested by Waterhouse (1963). Thus, *P*. *erythroseptica* is characterized by non-papillate sporangia, homothallism and entirely emphigynous antheridia. Based on this broad species concept, the pea isolate was treated as a variety of *P*. *erythroseptica*: *P*. *erythroseptica* var. *pisi* (Bywater & Hickman 1959) even though initially it was considered different enough to warrant a new species epithet: *P*. *pisi*, (Bywater, 1956). The acceptance of *P*. *erythroseptica* var. *pisi* as a validly published taxon is debatable. Article 37 of the International Code of Botanical Nomenclature (Voss, 1983) stipulates that "publication on or after 1 Jan. 1958 of the name of a new taxon of the rank of family or below is valid only when the nomenclatural type is indicated". Waterhouse (1963) considered *P*. *erythroseptica* var. *pisi*, which was published in 1959 without specifically citing a type specimen according to recommendations 37A and 37B, to be invalid. On the other hand, it is true that the nomenclatural type was clearly indicated in Bywater & Hickman's paper. We believe that this well-defined and well-described taxon should be retained. The isolate from wild rice is of special interest. Although it was identified as *P*. *erythroseptica* *sensu* *lato*, (Grunnel & Webster, 1988), it is different from the other isolates in its distinctly fluffy colony, larger sporangia, poor growth on malt extract agar medium, inability to hydrolyze starch, sensitivity to HMI and lack of pigment production on casein-hydrolysate medium (Ho, unpublished) and may be considered as a new variety. ATCC 10924, received originally as *P*. *drechsleri* (Ho & Jong, 1986), is now reclassified as *P*. *erythroseptica* based on its homothallism. The isolate of *P*. *erythroseptica* from sugarcane was identified primarily based on the production of oogonia with amphigynous antheridia in single cultures (Steib & Chilton, 1950; Van der Zwet & Forbes, 1961), but a detailed description of the fungus was not published. Based on the data and photographs in Singh's Ph.D. Thesis (1955), the unusually large oogonia (46.75 ± 4.11 μm diam), the rather large obypyriform sporangia (60.94 ± 6.25 X 37.38 ± 3.66 μm; L/B=1.6) and the spherical hyphal swellings spaced evenly in chains suggest greater similarity with the large-spore type of *P*. *megasperma* rather than P. erythroseptica sensu stricto. Perhaps, the antheridial configuration of the sugarcane isolate should be re-examined to determine if it produces any paragynous antheridia. Erwin (1965) initially identified the alfalfa isolate as P. cryptogea on account of its amphigynous antheridia but later renamed it as P. megasperma when paragynous antheridia were found.

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DEUTEROMYCOTINA FROM ANTARCTICA

NEW SPECIES OF HYPHOMYCETES FROM DANCO COAST, ANTARCTIC PENINSULA

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SUMMARY

Three new species of Hyphomycetes have been found recently in the Antarctic Continent, growing on rhizosphere soil of Colobanthus quitensis (Kunth) Bartl. (Caryophyllaceae) and Deschampsia antarctica Desv. (Gramineae).

The new species here proposed are: Acrodontium antarcticum nov. sp., Chalara antarctica nov. sp. and Phialophora dancoii nov. sp.

These new species were found during the "Campaña Antártica Argentina de verano 1989" in Danco Coast, Base Primavera (64º10'S, 60º57'W). The same locality is indicated in a map by Gamundí and Spinedi (1987).

The fungal isolation was carried out using the soil washing technique (Parkinson and Williams, 1961).

The following descriptions concerns observations in pure culture.

ACRODONTIUM ANTARCTICUM Cabello nov. sp. Fig. 1.

Coloniae in vitro post 20 dies 15 mm diametro, floccosae vel funiculosae, primum grisae ad olivaceae, mox nigrescentes. Reversum nigrum. Hyphae hyalinae ad pallide olivaceae, glabrae. Cellulae conidiogenae polyblasticae, integratae vel discretae, sympodiales, pallide brunneae, ad apicem pallidiores, plerumque 9-12 x 2.4-3 um et rachide tenuiter denticulata, recta vel flexuosa, 0.9-1 um crassa, ad 2.5-6.5 longa. Conidia acropleurogena, simplicia, hyalina, laevia, ovoidea basi apiculata, 2.5-3.5 x 1.5-2 um.
HOLOTYPUS: Antarctica, Peninsula Antarctica, Terra de Danco, Base Primavera, leg. M.N.Cabello, 31-I-1989. Ex solo. LPS 44594.

Colonies in vitro growing rather slowly, attaining a diam. of 15 mm in 20 days, appearing floccose or somewhat funiculose, at first grey to olivaceous, soon becoming blackish. Reverse black. Hyphae hyaline or pale olive, smooth. Conidiogenous cells polyblastic, integrated or discrete, sympodial, pale brown, paler towards the apex, 9-12 um hight, 2.4-3 um wide at the base,rachis denticulate often not distinctly differentiated from the basal part, straight or flexuous up to 2.5-6.5 um long and 0.9-1 um wide. Conidia acropleurogenous, hyaline, simple, smooth, ovoid, with an apiculate base, 2.5-3.5 x 1.5-2 um.

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Our species differs from A. crateriforme (van Beyma) de Hoog (de Hoog, 1972) by the smaller size of the conidiogenous cells and the denticulate rachis which in A. crateriforme can be up to 45 um while in our species is up to 6.5 um. It also differs by the lack of sharp denticles in our species.
Holotypus: Antartic Peninsula, Danco Coast, Base Primavera, leg. M.N.Cabello, 31-I-1989, rhizosfere soil of Colobanthus quitensis. LPS 44594.

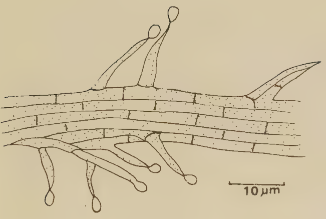
CHALARA ANTARCTICA Cabello, nov. sp. Fig. 2-4.

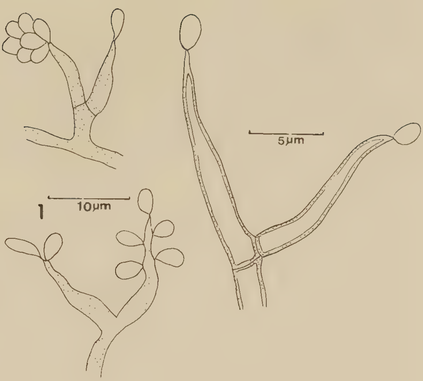
Coloniae in vitro post 30 dies 50 mm diametro, floccosae vel tomentosae, brunneae. Reversum brunneum. Phialophora erecta, simplicia, 1-4 cellularia, brunnea, cum phialidibus 60 um longa. Phialides elongatae, haut inflatae ad basim, 20-25 x 3 um; cylindraceo vel conico, interne 2-3 coniidis munitae, 7-10 um longa. Conidia ellipsoidea, hyalinea, 3-4 x 2-2.1 um. Chlamydosporae absunt.
HOLOTYPUS: Antarctica, Peninsula Antarctica, Terra de Danco, Base Primavera, leg M.N.Cabello, 2-II-1989. Ex solo. LPS 44595.

Colonies in vitro attaining a diameter of 50 mm in 30 days, appearing floccose or tufted, brown. Reverse dark brown. Phialophores erect, simple, bearing phialides. Total lenght of phialophores with phialides 60 um with 1-4 septa. Phialides with a medium brown, slightly or not inflated venter, 20-25 x 3 um, and a cylindrical or obconical, light brown collar, cointaining 2-3 conidia, 7-10 um long. Conidia ellipsoidal, hyaline 3-4 x 2-2.1 um. Aleuroconidia or chlamydospores absent.

The more related species are C. microspora (Corda) Hughes and C. neocaledoniae Dadant ex Kiffer and Delon. Our species differs from C. microspora (Nag Raj and Kendrick, 1975) by the size of the conidia (C. microspora 3-8.5 x 1-1.5 um, C. antarctica 3-4 x 2-2.1 um). It also differs from C. neocaledoniae (Kiffer and Delon, 1983) by the size of the phialide that is larger in this species.
Holotypus: Antarctic Peninsula, Danco Coast, Base Primavera, leg. M.N.Cabello, 2-II-1989, rhizosphere soil of Colobanthus quitensis and Deschampsia antarctica. LPS 44595.

ACRODONTIUM ANTARCTICUM. 1.Conidial structures and conidia.
CHALARA ANTARCTICA. 2. Conidiophore, phialide and conidia. 3. Phialides and conidia. 4. Conidia.
PHIALOPHORA DANCOII. 5. Phialides and conidia. 6. Conidia.

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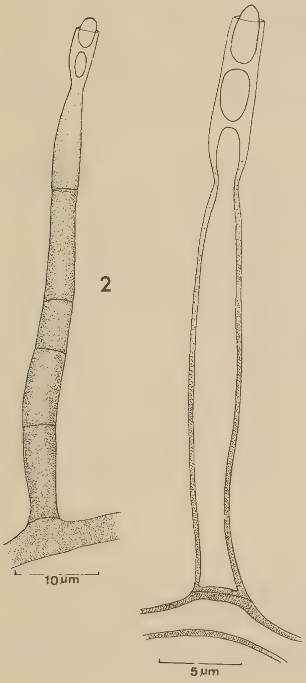
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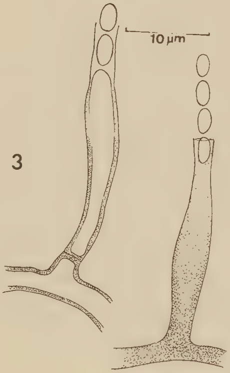
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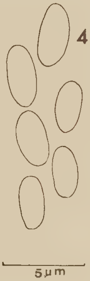
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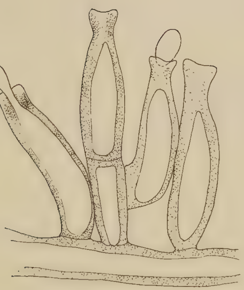

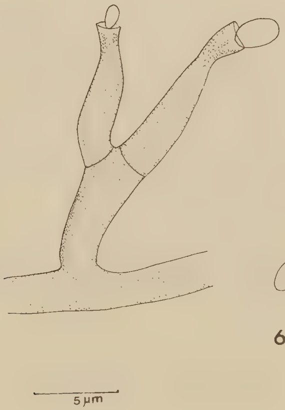
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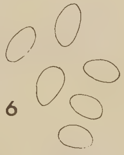
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PHIALOPHORA DANCOII Cabello nov. sp. Fig. 5-6.

Coloniae modice lente crescunt, olivaceo-grisae, pulverulentae, tomentosae. Reversum olivaceo-nigrum. Hyphae vegetativae modice pigmentatae, 1.2-2 um latae. Phialides simplices vel conidiophora composita ramosa; phialides brunneae, 11-12 x 2-3 um, collare 1-2 um altum divergens. Conidia agregata, ellipsoidea, hyalina, laevia, 2.5-5 x 1.5-2 um.
HOLOTYPUS: Antarctica, Peninsula Antarctica, Terra de Danco, Base Primavera, leg M.N.Cabello, 30-I-1989. Ex solo. LPS 44596.

Colonies reaching 36 mm diam. in 24 days at 20ºC; olivaceous grey, powdery and tufted. Reverse olivaceous black. Vegetative hyphae slightly pigmented, 1.2-2 um wide. Conidiophores consisting of simple phialides, sometimes septate and branched. Phialides brown, 11-12 x 2-3 um, collarette 1-2 um, slightly divergent. Sympodial proliferation absent. Conidia in heads, ellipsoidal, hyaline, smooth-walled, 2.5-5 x 1.5-2 um.

The species most closely related with P. dancoii is P. phaeophora Gams (Gams and Holubová-Jechová, 1976), but differs by the shape of the conidia which are dacryoid with a truncate base in Gams species.
Holotypus: Antarctic Peninsula, Danco Coast, Base Primavera, leg M.N.Cabello, 30-I-1989. Isolated from rhizosphere soil of Colobanthus quitensis. LPS 44596.

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STUDIES ON PHOLIOTA IN CULTURE

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ABSTRACT

Cultural characters are reported for 22 species of *Pholiota* and allied genera. One or several polarity tests have been made for most species in order to determine their mating systems. One species (*P. jahnii*) is bipolar, the others tetrapolar but some are amphithallic. The culture characters reported here add new information of value for intrageneric delimitations. Intercompatibility tests are performed where the species limits are unclear. One new combination is proposed: *Pholiota lignicola*(Peck)S. Jacobss.

INTRODUCTION

In modern fungal taxonomy studies of mycelia in culture play an important role. Culture characters have been described for a great number of species, especially those belonging to Polyporaceae and Corticiaceae s.l. Interfertility tests are increasingly used to delimit species and resolve discussions of synonymy at the species level. Sometimes the use of culture characters and interfertility tests is the only way to solve such problems. In Agaricales s. l. only fragmentary culture data are hitherto available but it is evident that they are valuable for a better understanding of the taxonomy. With earlier known methods only the saprophytic species have been cultured, thus many of the large, mycorrhizal genera are unknown in culture.

Pholiota (Fr.)Kummer is a genus of saprophytic species. Most species in the genus are active wood destroyers and, sometimes, they are parasitic.

Some live on charcoal, soil or humus but no species forms ectotrophic mycorrhiza. Since lignicolous species often are relatively easy to culture members of *Pholiota* were among the first agarics to be studied in that way.

Vandendries (1933 and 1934) and Vandendries & Brodie (1933) studied some species of *Pholiota* in culture and performed polarity tests. Kühner (1946) made morphological and caryological studies on *P. gummosa*. Denyer (1960) studied *Pholiota alnicola* in culture. The mating system in *P. adiposa* was studied by Arita & Mimura (1969) and later Arita (1979) published a comprehensive thesis on the cytology of *P. adiposa* and *P. nameko*. Farr, Miller & Farr (1977) carried out biosystematic studies in the *adiposa* group by using interfertility tests. Hübsch (1978) investigated the different types of conidia (accessory spores) in some species.

However, the published papers based on cultural studies of *Pholiota* are still rather few and only certain species are involved. One is *P. adiposa*, but as this name is interpreted in different ways (cfr Jacobsson 1987) it is not always clear which species had been studied.

The aim of this study is to get additional viewpoints for a better understanding of the systematic relationships within *Pholiota* by the aid of culture characters and interfertility tests. Twentytwo species belonging to *Pholiota* or allied genera have been cultured and studied in different ways.

MATERIAL AND METHODS

Collecting has taken place in various parts of Sweden and Denmark during 1979 - 1988. Basidiospores from collected basidiocarps were, as soon as possible, dispersed on plastic petri dishes with common malt agar for germination. From the germinated spores of each collection a number of monosporous mycelia were isolated. If a sufficient number of single spore (ss-)isolates were obtained, the breeding ability (the ability to form clamps in matings) and the mating-type was investigated by pairing all isolates with each other (polarity tests). The presence or absence of clamps, occurrence of accessory spores and other characters were examined when the mycelia had been in contact with each other for at least three or four weeks.

For some species no Swedish collections were available in culture. Mycelia of *Pholiota albocrenulata* and *P. lucifera* were obtained from CBS Baarn, the Netherlands. Compatibility tests between European and American specimens have been performed between Swedish material and some isolates of *P. alnicola*, *P. limonella* and *P. squarrosoides*, which were obtained from DAOM, Canada.

After the polarity tests, compatibility tests between different strains of the same species were performed. Compatibility tests between different forms were also made as a method to delimit closely related species or to confirm infraspecific variation. Intercompatibility is accepted as a strong support for conspecificity. Negative results consequently indicate different species but it is well known that there exist other explanations for negative pairings between specimens within a biological species, e.g. a reduction in mating capacity due to degenerative mutations or senescence (cfr Boidin, 1986).

Sometimes only polyspore (ps-) cultures with clamped hyphae were available for compatibility tests. They were then used in di-mon matings. In this type of crossing, a piece of a ps-mycelium is inoculated at the edge of a malt agar dish, while pieces of ss-cultures are inoculated in a half-circle around the ps-culture. After being in contact for four weeksor more the mycelium on the outside of the half-circle is checked for the occurrence of clamps (Buller phenomenon). Occurrence of clamps there is a strong support for conspecificy.

When partial compatibility or unexpected results appeared, the matings were repeated. There is a considerable variation between different species in many characters of the cultured mycelia, e.g. growth rate, appearance of the mycelial mat, width of the hyphae etc and accessory spores (conidia) of various kinds. In Polyporaceae and Corticiaceae a coded system developed by Nobles has been used for a long time to describe the morphology of polyspore cultures. This system is used herein to describe the Pholiotas. The codes are from Nobles (1965) with emendations by Boidin & Lanquetin (1983).

The production of the extra-cellular enzymes laccase and tyrosinase is studied by using several phenolic compounds in drop-tests. This method, the nature, effectiveness and reliability of different reagents is described in detail by Marr (1979). The procedure in this study follows Marr's directions. Small slices of tissue, about 10 mm diam and 5 mm thick, were removed from the mycelial colonies. The slices were placed in cavities of distilled-water rinsed, porcelain, depression plates. Systematically, the six reagents used (Syringaldazine, 1-Naphtol, Guaiacol, Gum Guaiac, P-cresol, L-tyrosine) were added to the tissues, each tissue submerged in several drops of one reagent. Syringaldazine and 1-Naphtol reagents are laccase-specific, p-Cresol and L-tyrosine are tyrosinase-specific.

Also nuclear staining in spores and mycelia has been made with giemsa according to Boidin (1958) in order to study the nuclear behavior in different stages. The terminology in this respect follows Boidin & Lanquetin.

The cultures are stored in the culture-collection at the Department of Systematic Botany, Gothenburg University. The GB-numbers refer to the culture-collection. The original specimens can be identified by the same number and are kept in the herbarium at Gothenburg (GB).

RESULTS

The basidiospores of many *Pholiota* species germinate easily in culture. However, the ability to germinate on common malt agar without any special arrangements varied within the genus. Spores from three species, *P. flammans*, *P. nematolomoides* and *P. astragalina*, never germinated in spite of several attempts. These species also have in common to grow on decayed coniferous wood. Also spores of *P. tuberculosa* were difficult to germinate, but eventually an attempt succeeded. In *P. highlandensis* only a few spores germinated. In most other species numerous spores germinated, but the vitality decreased rapidly after some days in storage. Spores stored more than a week generally did not germinate. In *P. alnicola* and *P. pinicola* the spore-prints had to be stored about two weeks in a freezer (ca - 5 C) before germinating occurred. Some attempts to culture these species without this treatment did not succeed.

Primary mycelia of most species of *Pholiota* grow rather rapidly and usually the two mycelia paired on a dish grew together within two or three weeks. Then they became completely interwoven or formed a more or less distinct barrier. A distinct barrier was usually combined with absence of clamps but exceptions to this rule occurred. Incomplete clamps were sometimes noted, generally in dishes where also genuine clamps were present. False clamps were rarely seen. In certain dishes, clamps were noted only on one side of the confrontation line (unilateral dikaryotization).

The positive pairings were compiled in pairing-tables to determine the mating-systems. However, the interpretation of the pairing tables were often more complicated than expected. Certain tables indicated bipolarity, others tetrapolarity, sometimes for the same species. Frequently irregularities appearad, failures to form clamps where expected but also clamps in combinations which at first sight seemed to be impossible.

CYTOLOGY:

The basidia in all species of Pholiota are normally four-spored. Most basidiospores in all species investigated contained two nuclei, which is the normal condition in Strophariaceae and other chromosporic Agarics (Kühner 1980). Certain spores seemed to contain one or more than two nuclei. Two nuclei in each spore is a result of three successive divisions of the fusion nucleus, the meiosis and two mitotic divisions, which yields eight nuclei. The third division occurs after the sterigmata are formed but the location in which it takes place is variable. Sometimes it occurs in the basidia, during the passage of the nuclei through the sterigmata or in the spores. Arita (1979), who studied the nuclear behaviour in *P. "adiposa"* (=*P. jahnii*?) and *P. nameko*, found that the third division took place in the spores in *P. adiposa* but this varied and frequently took place in the basidia in *P. nameko*.

The results of the polarity tests in this investigation show that it is common for the nuclei in certain basidiospores to contain different mating factors. In most pairing tables there occur positive pairings that can be explained only if the spores contain nuclei with two noncomplementary factors. Such heterocaryotic spores have been recognized in *Psathyrella candolleana* by Galland (1971). She showed that certain monosporic mycelia contained two types of nuclei incompatible because they possess the same allele for one of the mating type factors, A or B. Thus nuclei A2B2 and A2B1 may be found in the same primary mycelium. Undoubtedly the same conditions are common in most species of *Pholiota*. A tendency to "illegitimate copulations" between haplonts of the same strain occur also in *Coprinus* (Lange 1952). Future studies will reveal if this phenomenon is common also in other chromosporic genera.

Kühner (1977) considers that the discrepancies in pairing tables of tetrasporic species at least partly depends on spores borne on occasional basidia with only two or three sterigmata. Such spores may contain one or two additional nuclei which are genetically different. However, the number of spores with more than one mating factor appears to be higher than the corresponding number of basidia with less than four basidiospores. Perhaps spores with more than one mating factor germinate more easily. The occurrence of amphithallism may cause difficulty in interpreting some pairing tables. Mounce (1929) and Vandendries (1933) reported a bipolar mating type in *Pholiota adiposa* (=*P. jahnii*?) and *P. aurivella* respectively. However, Farr et al. (1977) found that although *P. aurivella* and *P. limonella* first appeared bipolar, a careful reexamination showed them to be tetrapolar. As already indicated by Ginns (1974) several cases of reported bipolarity were the results of misinterpretation. Rewriting of the original bipolar tables showed tetrapolarity. The reason for the misinterpretations was that the authors did not attempt to explain the irregularities that showed up in the pairing tables, e.g. the formation of clamps in pairings with presumably identical factors or failures in clamp-formation between assumed compatible pairings. Most of the pairing-tables in this investigation which indicate bipolarity are artificial, but *Pholiota jahnii* and possibly *Pholiota mutabilis* really seem to be bipolar or have bipolar forms.

Isolates from basidiospores of *Pholiota* usually germinate to nonclamped mycelia. The exceptions (approx. 10 - 20 %) may partly depend on dicaryotization between two germlings before they were isolated but probably spores with two compatible nuclei exist. However, such spores are produced only in a low number by chance and no species of *Pholiota* seems to be "secondarily homothallic" (Whitehouse 1949, Raper 1966). This term is applied to a species that regularily produce a high percentage of basidiospores with two compatible nuclei.

In some cases, e.g. in certain isolates of *P. gummosa* and *P. limonella*, clamps suddenly and unexpected have appeared in ss-mycelia months or years after germination. A spontaneous change of a mating type factor must have taken place. Such changes occur in *Psathyrella candolleana* (Galland 1971). A spontanoeous mutation of a mating factor may exceptionally be the explanation of an unexpected positive mating in a pairing table.

MYCELIA AND HYPHAE:

The appearance of the mycelia varied considerably between different species or groups of species. The surface of the mycelial mat is smooth in many species but distinctly granular in others. In *P. adiposa* and *P. limonella* distinct strands run over the surface. A cottony aerial mycelium is present in most species but there is variation between different mycelia of the same species. The advancing zones are generally even and appressed, with a few exceptions. These characters are described in the species descriptions and photos were taken of the cultures after six weeks growth (Fig. 1 - 3). Also the growth rate appeared to be very different.

Most hyphae in a mycelial colony are generally rather narrow (1 - 5 μm). The widths vary between the species but also between different isolates of the same species. On average the primary are narrower than the secondary mycelia. In all species certain hyphae become consideraby wider and frequently also more irregular in shape. In many species certain hyphae contain a row of short, swollen cells, which give them a moniliform appearance. Such cells appear both apically and intercalary. Also the frequency of oil-drops and other characters is variable (cfr fig. 8, *P. tuberculosa*).

The appearance of mycelia and hyphae seems to be very typical and constant within each species and therefore of a taxonomic value. Closely related species, e.g. *P. adiposa* and *P. limonella*, *P. spumosa* and *P. mixta*, *P. alnicola* and *P. pinicola*, are very similar in these characters.

ACCESSORY SPORES:

Most mycelia of Pholiotas, both ss- and ps-mycelia, form accessory spores in culture. Two types of accessory spores occur in the genus: arthrospores (oidia) and chlamydospores (aleuriospores). The arthrospores are generally formed on short, narrow branches (conidiophores) from certain hyphae on the surface of a mycelial colony. They arise as two or more cells in the apical parts of a branch and start as protoplasmic contraction followed by dissolution of the walls of the emptied parts of the hyphae. The process frequently takes place repeatedly on the same conidiophore. Sometimes the arthrospore-forming branches are coiled, e.g. in certain mycelia of *P. jahnii*. The spore-forming branches appear simple (for instance in *P. spumosa*) or in different-looking ramifications. Possibly also protoplasmic contraction in ordinary hyphae may lead to the formation of arthrospores.

Chlamydospores are formed in several species. They are very frequent,

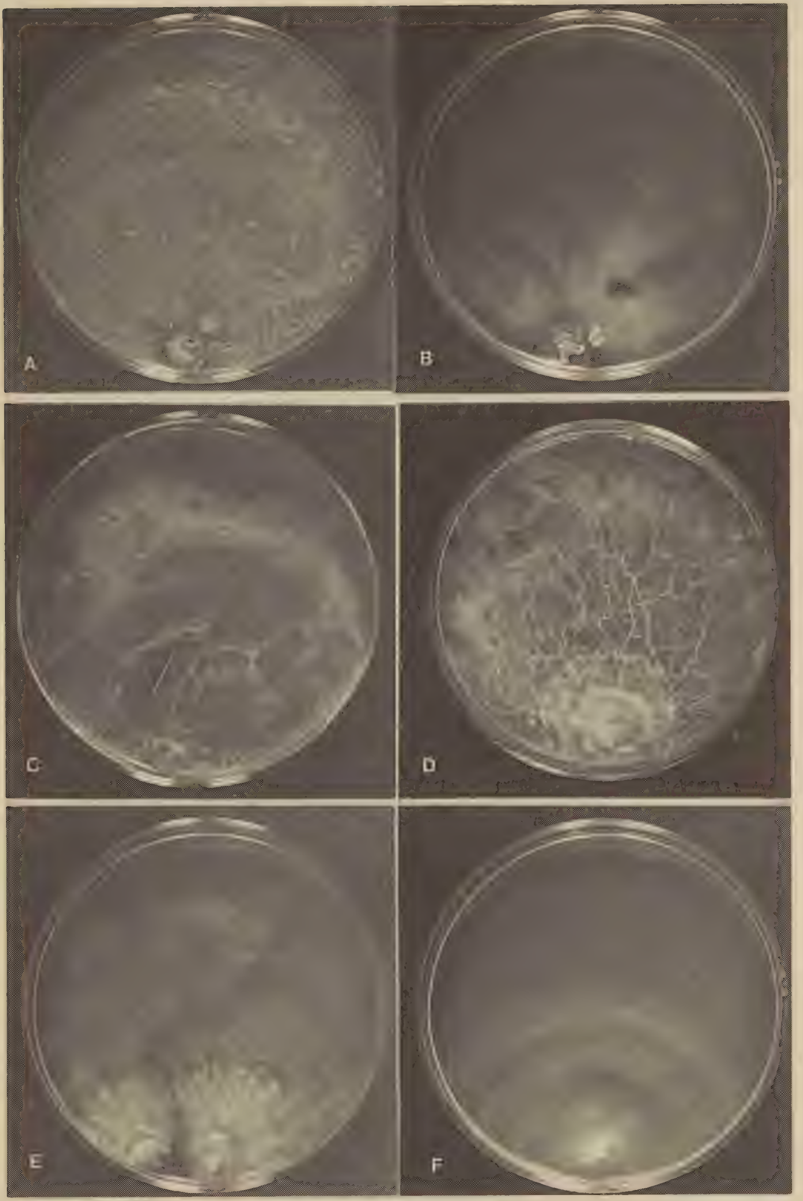

Fig. 1. Cultures after six weeks growth. a) Pholiota squarrosa, GB 1303, b) P. heteroclita, GB 1457, c) P. adiposa, GB 1071, d) P. limonella, GB 1456, e) P. jahnii, GB 1061, f) P. squarrosoides, GB 1458.

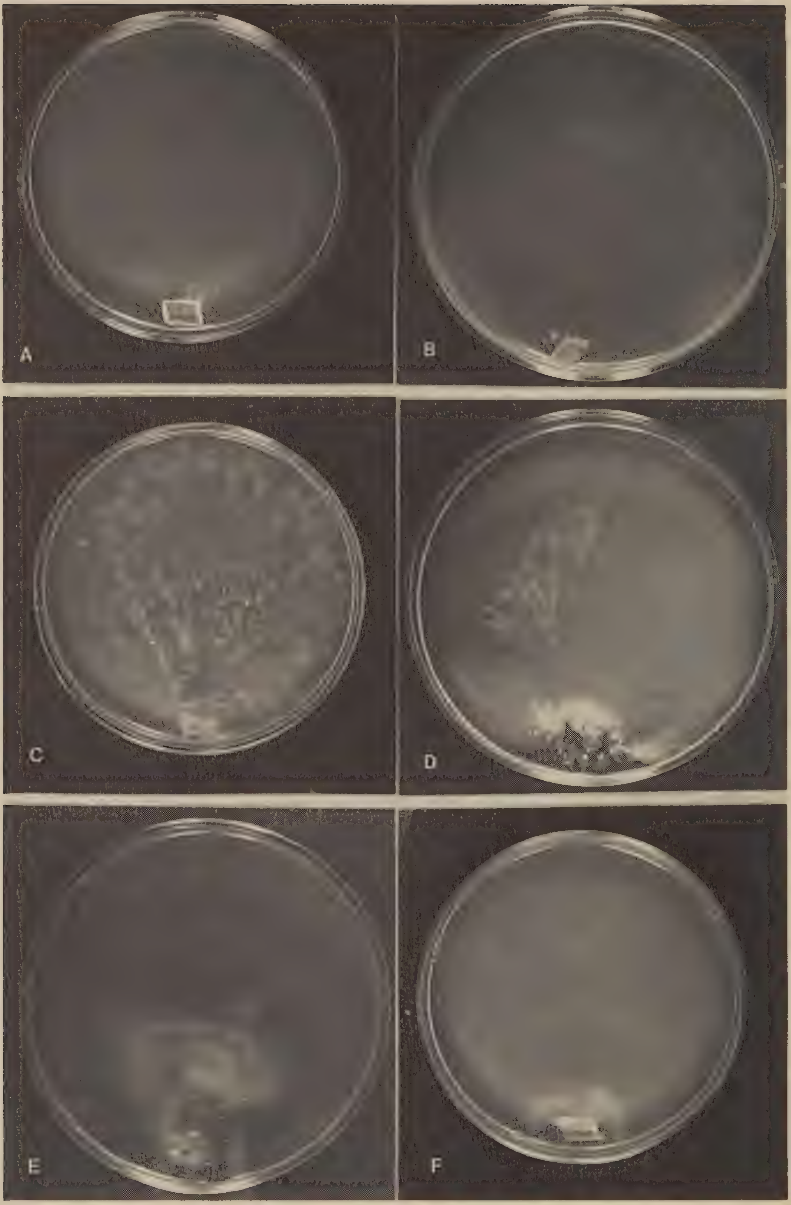

Fig. 2. Cultures after six weeks growth. a) Pholiota spumosa, GB 884, b) P. mixta, GB 948, c) P. lenta, GB 1060, d) P. lubrica, GB 1293, e) P. highlandensis, GB 1328, f) P. scamba, GB 1221.

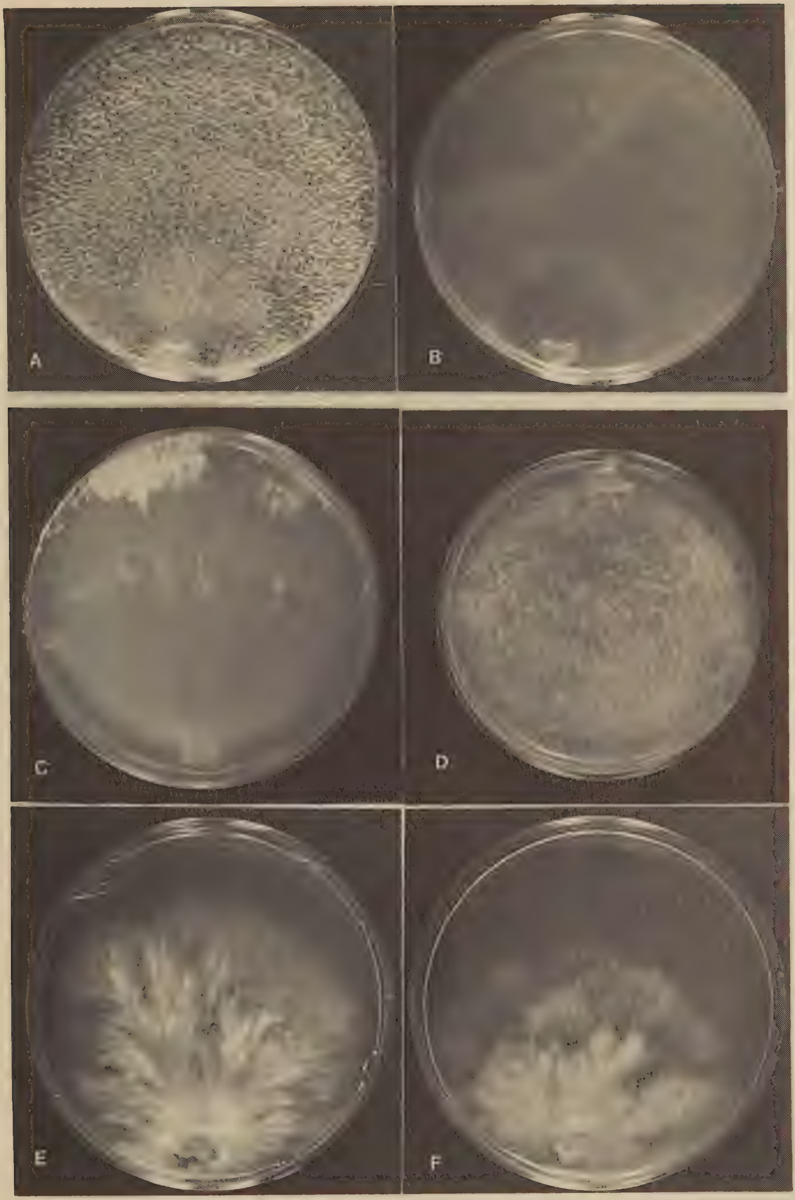

Fig. 3. Cultures after six weeks growth. a) Pholiota gummosa, GB 1295, b) P. graminis, GB 1273, c) P. tuberculosa, GB 1692, d) P. mutabilis, GB 1304, e) P. alnicola, GB 1243, f) P. pinicola, GB 1359.

large and conspicuous (15 - 30 x 10 - 20 μm) in certain species, e.g. *P. alnicola, P. pinicola, P. gummosa, P. graminis* and *P. squarrosa*, but less numerous and rather inconspicuous in others. They are formed both laterally and apically, frequently as the end-cell in a row of moniliform swellings. Chlamydospores occur anywhere in the mycelia but preferably in the submerged parts. Typical chlamydospores are not seen at all in some species, but probably any kind of swellings may loosen and then serve as a chlamydospore. Actually there is no fundamental difference between the two kinds of spores more than the size and shape. Of course chlamydospores are never so numerous as arthrospores, as they are produced for survival and not for dispersal as arthrospores.

The type and shape of accessory spores is very constant within each species and they are a systematically valuable character. However, they are not always formed by all isolates of the same stock. Genetical differences are probably responsible for presence or absence of accessory spores but also environmental conditions may play a role. Many species form only one type of accessory spore but both arthrospores and typical chlamydospores are seen in the same mycelial colonies of *Pholiota squarrosa* and *P. gummosa*. Arthrospores are common e.g. in the *adiposa* and *lubrica* groups and in *P. squarrosa* and *P. gummosa*. Conspicuous, moniliform swellings are especially common in *Pholiota tuberculosa* and *P. albocrenulata*.

Hübsch (1978) described the accessory spores of certain species of *Pholiota* and also illustrated some petri plates to illustrate their formation process. His results correspond well with those of this investigation.

DROP-TESTS:

The results of the drop-tests are presented in table I. The reactions were recorded 5 min., 30 min. and 2 hours after application of the reagents. In all cases where a positive reaction was recorded, it was visible within 30 min.

A positive response is an effect of oxidation and implies occurrence of enzymes. According to the investigations of Marr (1979) and others syringaldazine and 1-naphtol are laccase-specific. L-tyrosine and p-cresol reagents are tyrosinase-specific. Guaiac and guaiacol are nonspecific for laccase and tyrosinase but more effectively oxidized by laccase than tyrosinase.

In this study eleven species contained both laccase and tyrosinase: *jahnii*, *adiposa*, *limonella*, *squarrosoides*, *graminis*, *gummosa*, *scamba*, *spumosa*, *mixta* and *mutabilis*. Only tyrosinase is indicated in *squarrosa*, *heteroclita* and *lenta*. The reactions indicate only laccase in *junonius*, *highlandensis*, *lignicola* and *tuberculosa*. Neither laccase nor tyrosinase reaction is noted in the following species: *albocrenulata*, *alnicola* and *pinicola*.

Table I Result of drop-tests

+ = positive reaction, (+) = weak positive reaction, - = no reaction noted.

	Sy	N	Gl	G	p-C	Ty
adiposa	(+)	-	-	(+)	(+)	-
albocrenulata	-	-	-	-	-	-
alnicola	-	-	-	-	-	-
graminis	+	+	+	+	+	+
gummosa	+	-	(+)	-	-	-
heteroclita	-	-	-	-	+	(+)
highlandensis	-	+	-	(+)	-	-
jahnii	+	+	+	+	-	+
junonius	-	(+)	-	(+)	-	-
lenta	-	-	-	-	-	(+)
lignicola	+	(+)	(+)	+	-	-
limonella	-	(+)	-	(+)	+	-
lubrica	-	-	-	(+)	-	-
mixta	+	+	+	+	+	+
mutabilis	+	+	+	+	+	+
pinicola	-	-	-	-	-	-
scamba	+	+	+	+	+	+
spumosa	+	-	+	+	+	+
squarrosa	-	-	(+)	-	(+)	(+)
squarrosoides	-	-	(+)	-	-	(+)
tuberculosa	-	+	-	(+)	-	-

Abbrevations: Sy = syringaldazine, N = 1-Naphtol, Gl = guaiacol, G = guaiac, p-C = p-cresol, Ty = L-tyrosine.

The results of the spot tests in some species varied from the results in other studies. Käärik (1970) summarized results of spot tests and other culture characters for a large number of species, among them eight *Pholiota* species. She reported a strong laccase reaction in *P. heteroclita* and *P. squarrosa,* whereas no laccase was indicated in this study. She reported a weak tyrosinase reaction in *P. gummosa* and a strong laccase reaction in *P. adiposa*, which do not correspond with the result of this study. Marr (1979) studied *P. squarrosoides* and *P. lenta.* They were placed in the group of species with tyrosinase only, which corresponds with the results of this study.

Marr concluded that syringaldazine is the best reagent for laccase and L-tyrosinase or p-cresol the better reagents for detecting tyrosinase. It is therefore worth mentioning that laccase in *P. tuberculosa* and *P. high-*

landensis was indicated by a positive reaction with 1-naphtol but not syringaldazine.

The deviating results of different studies may depend on the fact that the localization of laccase and tyrosinase varies either among species or during ontogeny. These variations are associated with other processes, e.g. pigmentation or fruiting. Marr and Käärik performed their tests on tissues from basidiocarps, which may give other results than tests on mycelial colonies in culture. Also environmental factors, such as nutrition, temperature, pH, etc. influence the production of the enzymes. Results of drop-tests therefore must be interpreted carefully and preferably compared with other methods before conclusions can be reached.

CULTURE CHARACTERS FOR THE SPECIES

Pholiota squarrosa (Weigel:Fr.)Kummer

MATERIAL:
GB 165/ *Fagus*/Sweden, Halland, Tjolöholm (SJ 80261).
GB 1249/ *Picea*/Norway, Oppland, Ormtjernkampen (NH 8481).
GB 1299/ *Quercus*/Sweden, Västergötland, V.Tunhem (SJ 84157).
GB 1303/ *Quercus*/Sweden, Västergötland, Göteborg (SJ 84165).
GB 1535/ *Abies*/Romania, Neamt (NH 9201).

POLARITY: Only two polarity tests have been performed, both, however, with a rather small number of available isolates (Tab. 2). In 1249 only two positive pairings were observed. They indicate two different compatibility groups. The remaining isolates may belong to a third and same compatibility group but the negative pairings may be due to reduced fertility. In 1535 three compatibility groups (5 = A1B1; 1, 2, 6 = A2B2; 3, 4, 7 = A1B2) is the best interpretation of the result. Tetrapolarity therefore is the only reasonable mating system in *P. squarrosa.*

GB 1249, GB 1299, GB 1303, GB 1535 were compatible with each other. CYTOLOGY: Astatocoenocytic. The cells of the ss-mycelia contain a variable number of nuclei, at least 2 - 25 have been noted. Multinucleate hyphal cells are distinctly wider than others and occur especially in the terminal part of the hyphae. Multinucleate cells are also noted in a secondary mycelium (GB 1303) though most of them are dicaryotic.

CULTURE CHARACTERS (GB 1303): Growth moderately rapid, the dishes completely covered by mycelia in 3 - 4 weeks. Advancing zone even, appressed. Mycelial mat soon floccose, at first whitish, later yellowish with brown floccules (Fig. 1 A).

Reverse brownish. Hyphae usually 2 - 4 μm wide, regularly branched, with a clamp at all septa. Young, apical cells are frequently somewhat wider (3 - 6 μm) and more irregular in outline. Numerous arthrospores (6

- 10 x 3 - 4 µm) are formed by short branches from certain hyphae in the floccules on the surface. In the submerged part of the mycelium also large chlamydospores (10 - 16 x 8 - 12 µm) are rather common. Fig.4.

Tab. 2. Polarity tests in *Pholiota squarrosa.*

	GB 1249/2	GB 1249/3	GB 1249/4	GB 1249/5	GB 1249/6
GB 1249/1	-	-	-	-	-
GB 1249/2		+	-	-	-
GB 1249/3			-	+	-
GB 1249/4				-	-
GB 1249/5					-

	GB 1535/2	GB 1535/3	GB 1535/4	GB 1535/5	GB 1535/6	GB 1535/7
GB 1535/1	-	-	-	+	-	-
GB 1535/2		-	-	+	-	-
GB 1535/3			-	-	-	-
GB 1535/4				-	-	-
GB 1535/5					+	-
GB 1535/6						-

CODE: 2b, 3c, 26, 34, 35, 37, 39, 43-44, 49, 54, 60, 63. Oxidase reactions: weak reaction with guaiacol, p-cresol and L-Tyrosine, all other tests negative.

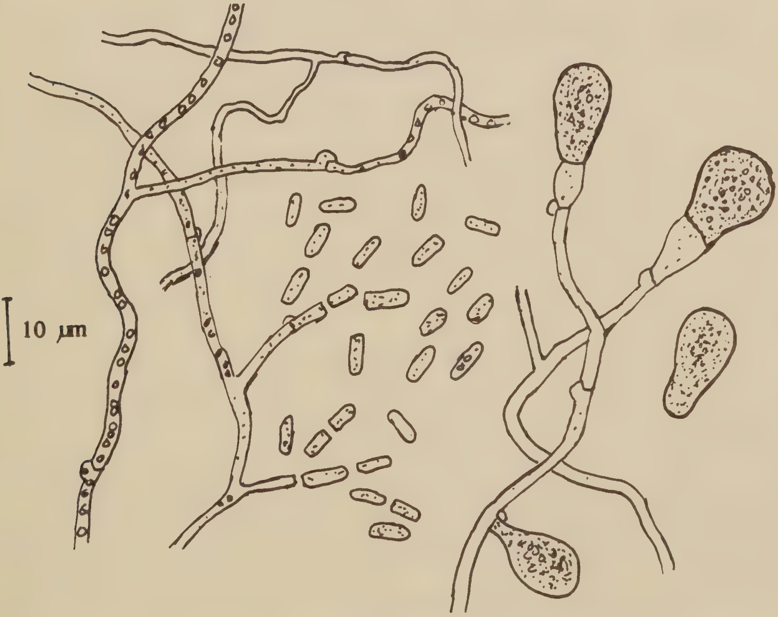

Fig. 4. Hyphae, arthrospores and chlamydospores in Pholiota squarrosa (GB 1303).

The cultural characters of *P. squarrosa* have much in common with *P. gummosa* (e.g. the appearance of the mycelia and the accessory spores) and indicate a relationship. According to Käärik (1965), *P. squarrosa* belongs to the group of species which produces both laccase and and tyrosinase. In this investigation only tyrosinase is verified. Possibly the weak reaction with guaiacol may be an indication of laccase. Käärik also reports a rather rapid growth rate for this species.

Pholiota limonella (Peck)Sacc.

MATERIAL:
GB 166/ *Alnus* trunk/Sweden, Göteborg, Naturparken (SJ 80286).
GB 1438/ *Betula*/Sweden, Västergötland, Långared (SJ 85056).
GB 1456/ cut trunk of *Quercus robur*/Sweden, Västergötland, Råda (SJ 85092).
GB 1508/ *Abies alba*/Romania, Neamt (NH 9200).
GB 1513/ Deciduous wood/Romania, Iasi (NH 9084).
GB 1597/ Substrate unknown/USA, VT 397 (Blacksburg, Virginia).
GB 1717/ *Populus*/Sweden, Medelpad, Borgsjö.
GB 1736/ *Alnus glutinosa*/Sweden, Uppland, Billudden.

The compatibility between these specimens and with the closely related *Pholiota adiposa* was dealt with in another paper (Jacobsson 1987).

POLARITY: Tetrapolarity is indicated but there are several irregularities, such as failures of clamp formation in supposed compatible pairings and occurrence of clamps in unexpected combinations. In several cases the only explanation for compatible pairings is that certain spores must contain two or more incompatible factors. It is not always easy to interpret a pairing table with total certainty due to irregularities which make more than one solution possible. The interpretation with the lowest number of mating failures and without positive matings between isolates assigned the same factors is considered to be the most probable one, at least theoretically. The pairing tables are showed in tab. 3.

In GB 166 the most reasonable interpretation is: 1 = A1B1; 5, 6 = A2B2; 3, 4, 7 = A1B2; 2 = A1B1+A2B1; 8 = A2B2+A2B1. There are two failures with this explanation (2 x 4, 2 x 7).

GB 1438: 4, 8 = A1B1; 5 = A2B2; 3, 7 = A1B2; 1, 2 = A2B2+A2B1. No 6 is excluded, as it did not result in any positive mating. This isolate is supposed to have a restricted fertility for some reason. With this interpretation there are two failures (1 x 7, 2 x 3), in other interpretations there are more failures.

GB 1456 is tetrapolar without failures: 1 = A1B1; 2, 4 = A2B2; 3, 5, 7 = A1B2; 6 = A2B1.

GB 1513. Amphithallic tetrapolarity is the only possible interpretation. If 1, 2, 3, 7 = A2B1+A1B1; 5 = A1B1; 8 = A2B2; 6 = A1B2; 4 = A2B1, there are no failures. Other interpretations are possible, but in those cases there are at least some failures.

GB 1717: This pairing table is difficult to interpret, but one interpretation indicates amphithallic tetrapolarity without failures: 1, 2 = A1B1; 3, 8 = A2B2; 5 = A1B2; 7 = A2B1; 10 = A1B1+A2B1; 9 = A2B2+A1B2.

Some polarity tests are excluded, because few isolates were available.

Tab. 3. Polarity tests in *Pholiota limonella*.

	GB 166/2	GB 166/3	GB 166/4	GB 166/5	GB 166/6	GB 166/7	GB 166/8
GB 166/1	–	–	–	+	+	–	+
GB 166/2		+	–	+	+	–	+
GB 166/3			–	–	–	–	+
GB 166/4				–	–	–	+
GB 166/5					–	–	–
GB 166/6						–	–
GB 166/7							+

	GB 1438/2	GB 1438/3	GB 1438/4	GB 1438/5	GB 1438/6	GB 1438/7	GB 1438/8
GB 1438/1	–	+	+	–	–	–	+
GB 1438/2		–	+	–	–	+	+
GB 1438/3			–	–	–	–	–
GB 1438/4				+	–	–	–
GB 1438/5					–	–	+
GB 1438/6						–	–
GB 1438/7							–

	GB 1508/2	GB 1508/3	GB 1508/4	GB 1508/5	GB 1508/6	GB 1508/7	GB 1508/8
GB 1508/1	–	+	+	–	–	–	+
GB 1508/2		+	+	–	–	–	+
GB 1508/3			–	+	–	–	+
GB 1508/4				+	+	+	+
GB 1508/5					–	–	–
GB 1508/6						–	–
GB 1508/7							–

	GB 1513/2	GB 1513/3	GB 1513/7	GB 1513/6	GB 1513/8	GB 1513/4	GB 1513/5
GB 1513/1	–	–	–	+	+	–	–
GB 1513/2		–	–	+	+	–	–
GB 1513/3			–	+	+	–	–
GB 1513/7				+	+	–	–
GB 1513/6					–	+	–
GB 1513/8						–	+
GB 1513/4							–

	GB 1717/2	GB 1717/3	GB 1717/5	GB 1717/7	GB 1717/8	GB 1717/9	GB 1717/10
GB 1717/1	–	+	–	–	–	(+)	–
GB 1717/2		+	–	–	(+)	(+)	–
GB 1717/3			–	–	–	–	+
GB 1717/5				+	–	–	+
GB 1717/7					–	+	–
GB 1717/8						–	+
GB 1717/9							(+)

	GB 1456/2	GB 1456/3	GB 1456/4	GB 1456/5	GB 1456/6	GB 1456/7
GB 1456/1	+	–	+	–	–	–
GB 1456/2		–	–	–	–	–
GB 1456/3			–	–	+	–
GB 1456/4				–	–	–
GB 1456/5					+	–
GB 1456/6						+

(+) means that only a few clamps were found, restricted to the confrontation line.

CYTOLOGY: Astatocoenocytic. The hyphal cells of a homocaryotic mycelial colony contain a various number of nuclei, 2 - 22 are counted. The highest number of nuclei is found in the youngest, terminal cell of a hypha. Most cells in the secondary mycelia are dicaryotic but multinucleate cells containing as many as 25 nuclei are also seen.
CULTURE CHARACTERS: Growth slow, dishes covered in 5 or 6 weeks. Advancing zone even, appressed. Aerial mycelium cottony-floccose, at first whitish, becoming yellowish brown in old parts. Conspicuous, branched strands run over the surface (Fig. 1 D). Reverse brownish. Hyphae 1 - 4 μm wide, regularly branched, with a clamp at most septa, hyaline or yellowish. Walls in old hyphae brown and incrusted. Numerous arthrospores (5 - 11 x 1,5 - 3 μm), formed by short branches from hyphae on the surface. Chlamydospores (8 - 30 x 5 - 10 μm) occur in submerged mycelia, but not numerous. Old hyphal cells in the submerged mycelia frequently becoming filled with reddish brown necropigments and finally broken in pieces (Fig. 5).
CODE: 2a, 2b, 3c, 16, 26, 34, 35, 37, 39, 45-46, 49, 54, 60, 63.
OXIDASE REACTIONS: Positive reaction with guaiac (very weak), p-Cresol and 1-Naphtol (weak), all other tests negative.

Pholiota limonella is closely related to *Pholiota adiposa* (*=aurivella* auct.). It is not possible to separate the two species in the basidiocarps. A slight difference in the spore size is the only reliable morphological character. Since this species earlier has not been distinguished by any European author, it is quite possible that published culture data (Vandendries 1933, Käärik 1970, Hübsch 1978 etc) of *Pholiota aurivella* (at least partly also *adiposa* and *squarroso-adiposa*) actually represent *Pholiota limonella*. However, so far no difference in the cultural characters have been found.

Pholiota adiposa (Batsch:Fr.)Kummer

MATERIAL:
GB 167/*Fagus*/Sweden, Halland, Grytsjön (SJ 80307).
GB 1072/*Fagus*/Sweden, Skåne, Silvåkra (SJ 83119).
GB 1291/*Salix* /Sweden, Skåne, Kristianstad (SJ 84131).
POLARITY: GB 167 and GB 1291 were tested (Tab. 4). In GB 167 only one positive pairing was obtained. In GB 1291 the only possible interpretation is amphithallic tetrapolarity: 8, 10 = A1B1; 1, 2, 5, = A2B2; 4, 6 = A1B2; 7 = A2B1; 9 = A2B2+A1B2. This explanation gives no failures.

The three mentioned specimens are intercompatible with each other. *Pholiota adiposa* is very closely related to *Pholiota limonella*. The taxonomy and the differences between them are published in an earlier paper

(Jacobsson 1987).

CYTOLOGY: Astatocoenocytic. Characters identical with those of *P. limonella.*

CULTURE CHARACTERS (GB 1072): Growth rate and general appearance identical with the closely related *P. limonella.* Advancing zone even, appressed. Later a cottony-floccose aerial mycelium is formed. Conspicous, branched strands run over the surface, at first whitish, soon yellowish to brownish (Fig. 1 C). Reverse brownish. Hyphae with a clamp at most septa, regularly branched, 1 - 4 μm wide. Numerous arthrospores (5 - 11 x 1,5 - 3 μm), formed in the same way and of the same appearance as in *P. limonella*

CODE: (2ab), 3c, 16, 26, 34, 35, 37, 39, 45-46, 49, 54, 60, 63.

OXIDASE TESTS: All tests negative in GB 1072. In GB 167 a positive but weak reaction with syringaldazine and p-cresol.

Tab. 4. Polarity tests in *Pholiota adiposa.*

	GB 167/2	GB 167/3	GB 167/4	GB 167/5	GB 167/6
GB 167/1	+	–	–	–	–
GB 167/2		–	–	–	–
GB 167/3			–	–	–
GB 167/4				–	–
GB 167/5					–

	GB 1291/2	GB 1291/5	GB 1291/4	GB 1291/6	GB 1291/7	GB 1291/9	GB 1291/8	GB 1291/10
GB 1291/1	–	–	–	–	–	–	+	+
GB 1291/2		–	–	–	–	–	+	+
GB 1291/5			–	–	–	–	+	+
GB 1291/4				–	+	–	–	–
GB 1291/6					+	–	–	–
GB 1291/7						+	–	–
GB 1291/9							+	+
GB 1291/8								–

This species is better known as *Pholiota aurivella* (Batsch:Fr.)Kummer. However, as this name has been recently questioned (Kuyper & Tjallingii-Beukers 1986) and *Pholiota adiposa* in its original sense undoubtedly is correct (cfr Jacobsson 1987) a name change to *P. adiposa* is unavoidable.

The confusing taxonomy in this group implies that published data on *Pholiota aurivella* should actually be referred to *Pholiota adiposa* or the almost indistinguishable *Pholiota limonella.* On the other hand, published data on *Pholiota adiposa*, at least in recent time (Hübsch 1978, Arita 1979) should be transferred to *Pholiota jahnii.*

Pholiota "aurivella" is one of the most studied species of the genus. Martens & Vandendries (1932) and Vandendries (1933) reports bipolarity for this species, which seems unlikely when compared with later investigations (Farr, Miller and Farr 1977, and those in this paper, cfr *Pholiota jahnii*). Hübsch (1968) noticed the occurrence of arthrospores and Käärik (1970) a strong reaction both for laccase and tyrosinase together with some other characters. Only weak reactions for laccase and tyrosinase reaction were noted in this investigation. The difference may depend on the fact that Käärik used basidiocarp tissue for her tests.

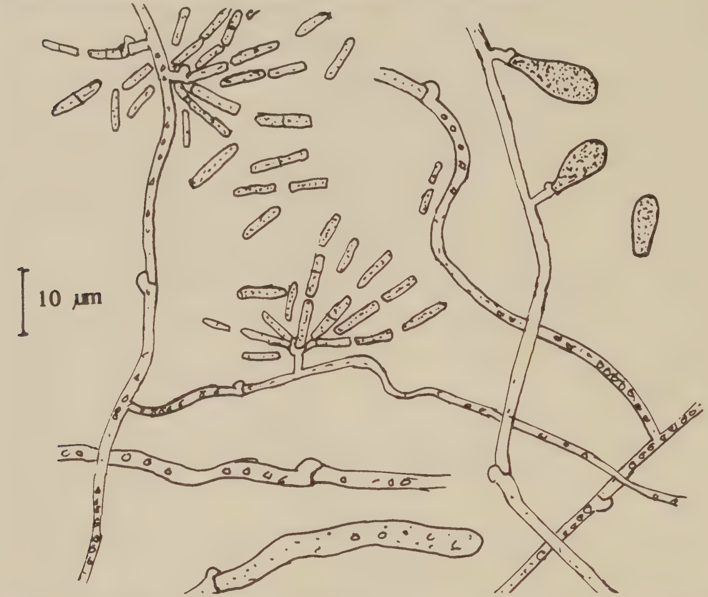

Fig. 5. Hyphae, arthrospores and chlamydospores in Pholiota adiposa (GB 1291).

Pholiota jahnii Tjall. & Bas

MATERIAL:
GB 83/*Fagus*/Sweden, Skåne, Bökebergsslätt (SJ 79231).
GB 164/*Fagus*/Danmark, Själland, Vordingborg (SJ 80210).
GB 1061/*Fagus*/Sweden, Skåne, Silvåkra (SJ 83118).
GB 1305/*Fagus*/Sweden, Blekinge, Sölvesborg (L. Örstadius).
GB 1342/probably *Picea*/Sweden, Södermanland, Överjärna (K.Jaederfeldt).
GB 2021/buried wood, probably *Fagus*/Sweden, Skåne, Silvåkra (SJ88061).

POLARITY. Polarity tests have been performed with the specimens GB 83, GB 1061, GB 1305, GB 1342 and GB 2021 (Tab. 5).

In GB 1342 only two positive pairings were yielded, which indicates a restricted fertility for some reason. The result of the other four polarity tests clearly indicates bipolarity. However, there is one failure in GB 1061 (4 x 9).

All specimens are completely intercompatible with each other (Jacobsson 1987).

Tab. 5. Polarity tests in *Pholiota jahnii.*

	GB 83/2	GB 83/6	GB 83/7	GB 83/3	GB 83/4	GB 83/5	GB 83/8	GB 83/10
GB 83/1	-	-	-	+	+	+	+	+
GB 83/2		-	-	+	+	+	+	+
GB 83/6			-	+	+	+	+	+
GB 83/7				+	+	+	+	+
GB 83/3					-	-	-	-
GB 83/4						-	-	-
GB 83/5							-	-
GB 83/8								-

	GB 1305/2	GB 1305/3	GB 1305/5	GB 1305/7	GB 1305/4	GB 1305/6
GB 1305/1	-	-	-	-	+	+
GB 1305/2		-	-	-	+	+
GB 1305/3			-	-	+	+
GB 1305/5				-	+	+
GB 1305/7					+	+
GB 1305/4						-

	GB 1061/7	GB 1061/8	GB 1061/5	GB 1061/6	GB 1061/9
GB 1061/4	-	-	+	+	-
GB 1061/7		-	+	+	+
GB 1061/8			+	+	+
GB 1061/5				-	-
GB 1061/6					-

	GB 1342/2	GB 1342/3	GB 1342/4	GB 1342/5	GB 1342/6	GB 1342/7	GB 1342/8	GB 1342/9	GB 1342/10
GB 1342/1	-	-	-	-	-	-	+	-	-
GB 1342/2		-	-	-	-	-	-	-	-
GB 1342/3			-	-	-	-	-	-	-
GB 1342/4				-	-	-	-	-	-
GB 1342/5					-	-	+	-	-
GB 1342/6						-	-	-	-
GB 1342/7							-	-	-
GB 1342/8								-	-
GB 1342/9									-

	GB 2021/2	GB 2021/3	GB 2021/4	GB 2021/5	GB 2021/6	GB 2021/7	GB 2021/8	GB 2021/9	GB 2021/10
GB 2021/1	-	-	-	-	-	-	+	-	+
GB 2021/2		-	-	-	-	-	+	-	+
GB 2021/3			-	-	-	-	+	-	+
GB 2021/4				-	-	-	+	-	+
GB 2021/5					-	-	+	-	+
GB 2021/6						-	+	-	+
GB 2021/7							+	-	+
GB 2021/8								-	+
GB 2021/9									+

CYTOLOGY (GB 1061): Heterocytic. Terminal cells of ss-mycelia are multinucleate and wider than most intercalary cells, which generally contain two nuclei. In the secondary mycelium only clamped, binucleate cells are found.

CULTURE CHARACTERS (GB 1061): Growth slow, dishes covered in six weeks. Advancing zone even, appressed. Aerial mycelium cottony, whitish, but becoming slightly yellowish brown in patches in old parts (Fig. 1 E). Reverse somewhat brownish. Hyphae generally 1 - 3 μm wide, regularly

branched, with a clamp at all septa. Numerous arthrospores (3 - 6 x 1 - 3 μm) are formed at the surface of the mycelial colony (Fig. 6). Chlamydospores (8 - 45 x 6 - 10 μm) rather rare, only seen in certain mycelia. Many old hyphae are filled with dark reddish-brown necropigments and easily broken to pieces.
CODE: 2ab, 3c, 26, 34, 35, 37, 39, 46, 49, 54, 59, 63.
OXIDASE REACTIONS: Positive reactions noted for all tests except p-cresol.

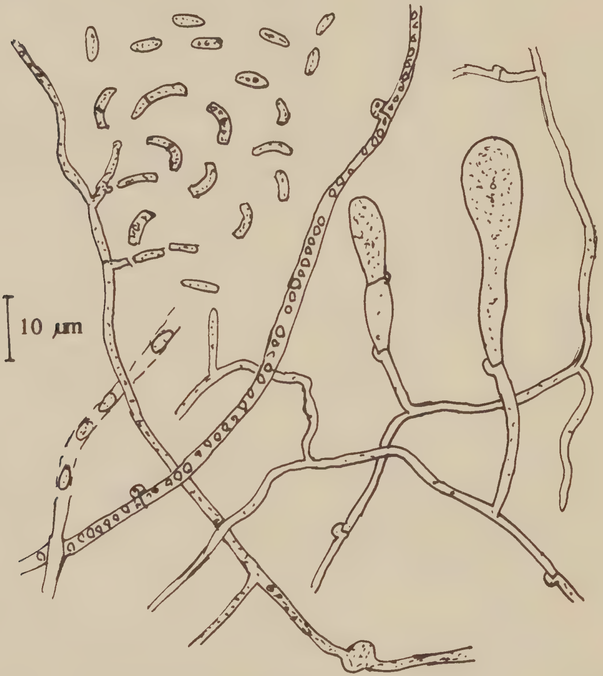

Fig. 6. Hyphae, arthrospores and chlamydospore forming in Pholiota jahnii (GB 1061).

Pholiota jahnii is a recently created new name for the species earlier known as *Pholiota muelleri* (Fr.)Orton. It also includes *Pholiota adiposa* auct. (ss Lange etc, cfr Jacobsson 1987). Therefore most published data on *Pholiota adiposa* (e.g. Arita & Mimura 1969, Arita 1979) probably refer to *Pholiota jahnii*.

The most remarkable character of *Pholiota jahnii* is the bipolarity. Three polarity tests clearly indicate bipolarity, which result corresponds with earlier reports. Arita and Mimura (1969) reported *Pholiota "adiposa"* to be bipolar. Vandendries (1933) reports a perfect bipolarity in a test with 16 isolates of *Pholiota "aurivella"*. The latter species is definitely not bipolar and it is more probable that he had collected *P. jahnii*, a species not known at that time.

The strong reaction for both laccase and tyrosinase corresponds well with the report of Käärik (1970).

Pholiota squarrosoides (Peck)Sacc.

MATERIAL:
GB 1458/on dead *Populus* trunk/Sweden, Uppland, Bondkyrka, (S.Ryman 8065).
GB 1680/Canada, Br.Col., Stamp Falls, polysporous & tissue cultures isolated from fruit body (2 cultures, but without clamps, DAOM 22113).
POLARITY: GB 1458 is tested regarding the mating type (Tab. 6). Amphithallic tetrapolarity is the only possible interpretation. If 6, 7 = A1B1; 1, 5 = A1B2; 2 = A2B1; 4 = A2B2+A1B2; 3 = A2B2+A2B1, there is only one failure (1 x 2).

Tab. 6. Polarity test in *Pholiota squarrosoides*.

	GB 1458/2	GB 1458/3	GB 1458/4	GB 1458/5	GB 1458/6	GB 1458/7
GB 1458/1	–	–	+	–	–	–
GB 1458/2		+	–	+	–	–
GB 1458/3			+	–	+	+
GB 1458/4				–	+	+
GB 1458/5					–	–
GB 1458/6						–

The Swedish and Canadian specimens turned out to be incompatible. However, other explanations than species differentiation are possible. The absence of clamps in DAOM 22113, in spite of the fact that it originates from a basidiocarp, indicates that a degenerative mutation has taken place and a restricted mating ability therefore is probable. These cultures were made in 1949.
CYTOLOGY (GB 1458): Probably heterocytic. All hyphae in the secondary mycelium are clamped and binucleate.
CULTURE CHARACTERS (GB 1458): Growth very slow, reaching 50 - 52 mm and not covering the dishes in six weeks. Advancing zone even, appressed. Aerial mycelium almost absent, but the surface of the mat with numerous minute granules, whitish -yellowish (Fig. 1 F). Reverse weakly brownish. Hyphae 1 - 5 μm wide, regularly branched, with a clamp at most septa. Arthrospores (3 - 8 x 1 - 3 μm, frequently curved) are formed by irregular, short branches in the granules on the surface (Fig. 7). A few

rather small and inconspicuous chlamydospores (9 - 15 x 6 - 8 μm) are seen.

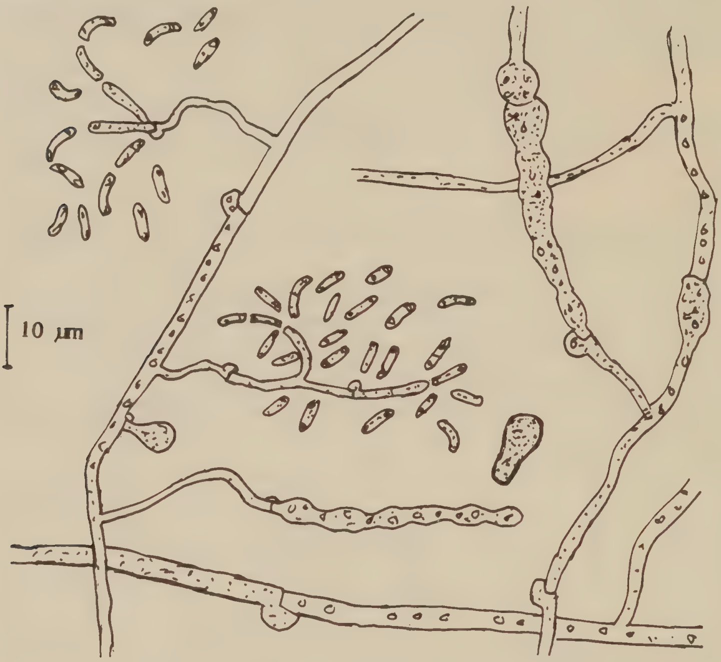

Fig. 7. Hyphae, arthrospores and chlamydospores in Pholiota squarrosoides (GB 1458).

CODE: (2ab), 3c, 26, 34, 35, 37, 39, 47, 49, 54, 60, 63.
OXIDASE REACTIONS: All tests negative.

No data on culture characters for *Pholiota squarrosoides* are published previously. The species apparently belongs to the *adiposa* group, based on its characters, e.g. the occurrence of arthrospores, which are similar to those of the other species in the group. However, it differs from the other species in the negative reactions for laccase and tyrosinase.

Pholiota tuberculosa (Schff.:Fr.)Kummer

MATERIAL:
GB 1692/*Tilia*/Sweden, Västergötland, Trollhättan (SJ 86019).
POLARITY: 7 isolates of the specimen GB 1692 were mated in all possible combinations but no positive pairings appeared. Thus the mating type of this species is still unknown.

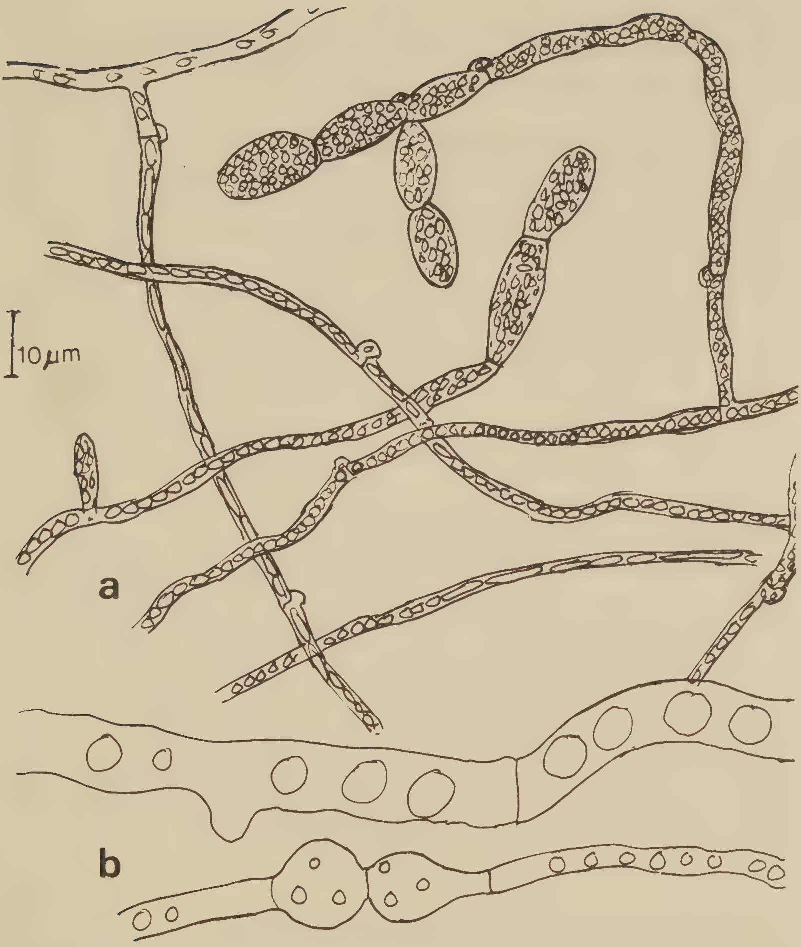

Fig. 8. Hyphae in Pholiota tuberculosa (GB 1692). A) in ps-mycelium, B) in ss-mycelium.

CYTOLOGY: Not studied.

CULTURE CHARACTERS: Growth rapid, the dishes completely covered in two weeks. Advancing zone somewhat fringed. Aerial mycelium cottony, slightly yellowish. Reverse brownish. Normal hyphae 3 - 5 µm wide, regularly branched and with a clamp at all septa, densely filled with oil-drops. Certain hyphae have a moniliform appearance with short and very broad (10 - 30 µm) cells. The ss-mycelia to a great extent consist of very wide (- 20 µm) hyphae, with very big, sometimes strongly yellow, oildrops (Fig. 8). Sometimes bladder-like cells seem to serve as chlamydospores.

CODE: 2a, 3c, 26e, 34, 37, 39, 42, 49, 54, 58.
OXIDASE REACTIONS: Positive but weak reactions with guaiac and 1-Naphtol, otherwise negative.

Pholiota tuberculosa has not been studied in culture before. Some of the cultural characters such as the rapid growth rate and the very wide hyphae densely filled with oildrops differ considerably from other *Pholiota* species and indicate that this species takes a rather isolated systematic position in the genus.

The species seems to be difficult to culture, as spores from one specimen only germinated. Some other attempts have been unsuccessful. It is desirable with more cultures to verify the results.

Pholiota lucifer (Lasch)Quél.

MATERIAL:
GB 1852/*Abies*/Austria/CBS 595.82 (1 ps-culture).
The culture characters of this strain appeared to be almost identical with those of *P. adiposa - limonella* and suggest that *P. lucifer* belongs to this complex. However, this seems unlikely, as the morphological characters are very different and more similar to those of *P. tuberculosa*. Compatibility tests by using Buller's phenomenon have been performed with *P. limonella* (GB 1456) and *P. adiposa* (GB 1072). They were found to be negative. In spite ot that it is possible that the culture descends from a misidentified basidiocarp. No herbarium material is preserved to check the determination. It is desirable to get the culture characters verified by another strain before conclusions.

Pholiota heteroclita (Fr.:Fr.)Quél.

MATERIAL:
GB 1457/*Betula*/Sweden, Halland, Lindome (SJ 85093).
POLARITY: 8 isolates of GB 1457 were mated in all possible combinations. However, the mycelia ceased to grow after a while and only in two combinations were clamps formed and then there were only a few.
CYTOLOGY: Not studied.
CULTURE CHARACTERS: Growth rate very slow for the genus, in six weeks the mycelia had reached only 30 - 37 mm. Advancing zone somewhat uneven and fringed. Aerial mycelium downy, slightly plumose, whitish in young parts, gradually becoming brownish. Reverse somewhat brownish. Hyphae 1 - 3 μm wide, not very differentied, regularly branched, with a clamp at most septa. Numerous arthrospores formed in

the aerial mycelium by short branches in terminal or lateral, brush-like clusters (Fig. 9), rather different-looking compared with those in other Pholiotas. Occasionally small intercalary or terminal swellings appear.
CODE: 2b, 3c, 7, 35, 37, 39, 47, 49, 54, 58.
OXIDASE REACTIONS. Positive reactions with L-Tyrosine (very weak) and p-Cresol, otherwise negative.

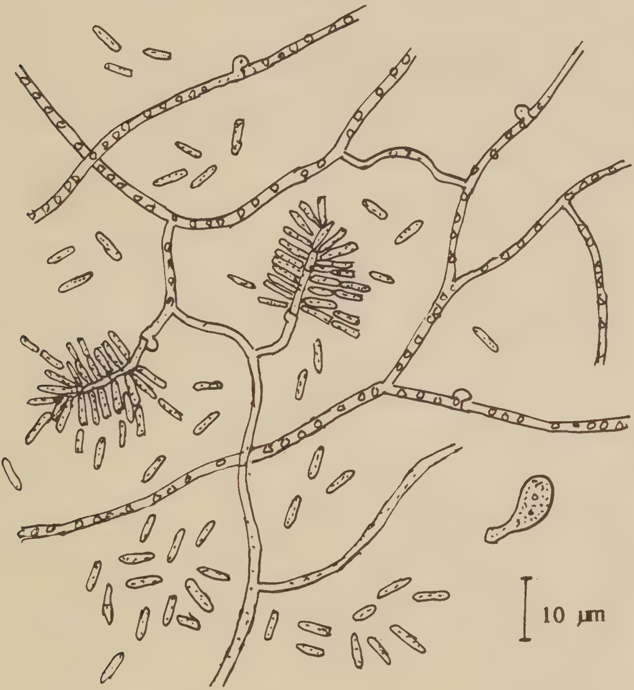

Fig. 9. Hyphae, arthrospores and a chlamydospore in Pholiota heteroclita (GB 1457).

The culture characters, especially the diverging appearance of the arthrospore-forming conidiophores, suggest a rather isolated systematic position of this species. It is often placed in a separate subgenus (*Hemipholiota*) together with some other species. *Pholiota populnea* is generally considered to be a close relative, unfortunately no strain of this species has been available. Hübsch (1978) reports, however, that no accessory spores at all were found in any of three stocks of *P. populnea*.

Pholiota highlandensis (Peck)Smith & Hesler

MATERIAL:
GB 1247/ burnt spot/Sweden, Västergötland, Alingsås (SJ 84091).
GB 1306/ burnt spot/Sweden, Göteborg, Botanical garden (SJ 84168).
GB 1328/ burnt spot/Sweden, Halland, Morup (SJ 84174).
GB 1693/ burnt spot/Finland, PH., Konnevesi, Siikakoski (I.Järvinen).

POLARITY: GB 1247, GB 1306, GB 1693 are tested (Tab. 7). Tetrapolarity is indicated and in GB 1247 and GB 1306 there also occur some positive pairings which could only be explained if spores with more than one factor are present. The following interpretations are made:

Tab. 7. Polarity tests in *Pholiota highlandensis*.

	GB 1247/2	GB 1247/3	GB 1247/4	GB 1247/5	GB 1247/6
GB 1247/1	–	–	+	+	+
GB 1247/2		–	–	–	–
GB 1247/3			+	+	+
GB 1247/4				–	+
GB 1247/5					+

	GB 1306/2	GB 1306/3	GB 1306/4	GB 1306/5	GB 1306/6
GB 1306/1	–	–	+	–	–
GB 1306/2		–	+	–	–
GB 1306/3			–	–	–
GB 1306/4				–	+
GB 1306/5					–

	GB 1693/2	GB 1693/3	GB 1693/4	GB 1693/5	GB 1693/6	GB 1693/7
GB 1693/1	–	+	+	–	+	+
GB 1693/2		–	–	–	–	–
GB 1693/3			–	+	–	–
GB 1693/4				+	–	–
GB 1693/5					+	+
GB 1693/6						–

GB 1247: A possible interpretation is 1, 3 = A1B2; 4, 5 = A2B1; 6 = A2B2+A1B2. If nr 2 = A2B2, the table shows no failure. However, this mycelium looked very different compared with the others (more brownish) and a much more clear confrontation line than in all other matings was formed. It therefore seems reasonable that this mycelium was incompatible for other reasons.

GB 1306: 3, 5 = A1B1; 4 = A1B2; 1, 2 = A2B1; 6 =A1B1+A2B1. No failures.

GB 1693: 1, 5 = A1B1; 3, 4, 6, 7 = A2B2; 2 = A1B2 or A2B1. Only three compatibility groups were detected, which is reasonable with only 7 isolates.

INTERCOMPATIBILITY TESTS: The following tests have been performed: 1247 x 1328, 1247 x 1693, 1306 x 1693. These specimens were found to be intercompatible. Only in one dish were no clamps found (1247/3 x 1693/3). Macroscopically the basidiocarps looked rather different.

CULTURE CHARACTERS (GB 1328): Growth moderately rapid, dishes covered in three weeks. Advancing zone even, appressed. Aerial mycelium downy, whitish but slightly yellow in old parts (Fig. 2 E). Reverse pale yellowish brown. Hyphae rather narrow, mostly 1 - 3 μm wide, occasionally - 5 μm, regularly branched and with a clamp at all septa. A few hyphae consist of separate or a row of more or less swollen cells (5 - 10 μm wide), which probably may serve as chlamydospores. Occasional slight intercalary swellings also seen (Fig. 10). Arthrospores not seen.

CODE: 2a, 3c, 26e, 34?, 37, 39, 43, 49, 56, 60.

OXIDASE REACTIONS: Positive reaction with syringaldazine, guaiac and guaiacol, otherwise negative.

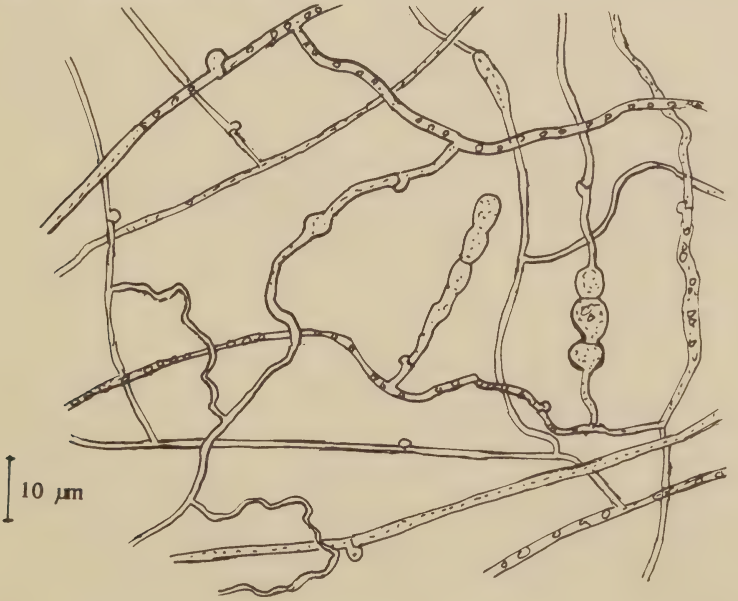

Fig. 10. Hyphae in Pholiota highlandensis (GB 1328).

No data on cultural characters have been previously published for this species. Systematically, it undoubtly belongs to the *lubrica* group (subgenus *Lubricula*). Morphologically it has much in common with *Pholiota spumosa* but in the culture characters they clearly differ.

The basidiocarps of the four stocks in this investigation varied considerably in size and colour but were found to be intercompatible. Some mycologists (cfr Smith & Hesler 1968, Orton 1988) recognize several closely related species growing on charcoal. It is quite possible that more than one species exists but as the morphological characters, especially the pigmentation, vary with the age of the basidiocarp and are influenced by external factors, it should be confirmed by interfertility tests. *Pholiota carbonaria* A.H. Smith is described from the USA and is said to differ from *P. highlandensis* in the distinctly red veil. It is desirable to have interfertility tests made between this species and *P. highlandensis*.

Only a very low number of spores germinate. Probably it depends on a factor connected with the special habitat as basidiospores from all other species of this group are easily germinated on common malt agar. The habitat burned wood indicates that it is adapted to a high concentration of minerals.

Pholiota spumosa (Fr.)Sing.

MATERIAL:
GB 884/*Picea*/Sweden, Medelpad, Borgsjö (SJ 83069).
GB 1245/*Picea*/Sweden, Västergötland, Skepplanda (SJ 84089).
GB 1349/*Picea*/Sweden, Medelpad, Tuna (SJ 84187).
POLARITY: Two polarity tests are performed (Tab. 8).

Tab. 8. Polarity tests in *Pholiota spumosa*.

	GB 884/2	GB 884/3	GB 884/4	GB 884/5	GB 884/6	GB 884/7	GB 884/8	GB 884/9
GB 884/1	+	–	–	+	–	–	–	–
GB 884/2		+	–	+	–	–	+	–
GB 884/3			+	+	–	–	–	–
GB 884/4				–	–	–	–	+
GB 884/5					–	+	–	+
GB 884/6						–	+	–
GB 884/7							–	–
GB 884/8								–

	GB 1245/2	GB 1245/3	GB 1245/4	GB 1245/5	GB 1245/6
GB 1245/1	–	–	(+)	–	–
GB 1245/2		–	–	–	(+)
GB 1245/3			–	–	+
GB 1245/4				–	–
GB 1245/5					–

(+) means only a few clamps seen in the contact zone.

The pairing table of GB 884 is complicated and difficult to interpret. Several explanations are possible, that with the fewest failures is: 9, 7 = A1B1; 4 = A2B2; 8 = A1B2; 6 = A2B1; 1, 3 = A1B1+A1B2; 5 = A2B2+A1B2; 2 = A2B2+A2B1. However, there are 5 failures (1 x 6, 2 x 7, 2 x 9, 3 x 6, 5 x 6). It seems impossible to interpret these results with certainty, but spores with more than one factor must be involved (amphithallic tetrapolarity).

GB 1245 is easily interpreted as normally tetrapolar: 1, 5 = A1B1; 4 = A2B2; 2, 3 = A1B2; 6 = A2B1. However, there is then one failure (4 x 5).

Also GB 1349 is tested but in this specimen (8 isolates) no clamps were formed in any combination.

CYTOLOGY: The spores are binucleate. Ss-mycelia are in terminal cells multinucleate, otherwise generally binucleate (heterocytic behaviour). Only dicaryotic cells seen in ps-mycelia.

INTERCOMPATIBILITY TESTS: Tests have been performed between the specimens 884/1245 and 1245/1349. They proved to be completely interfertile. Clamps were formed in all dishes and no distinct confrontation line between the different mycelia was seen.

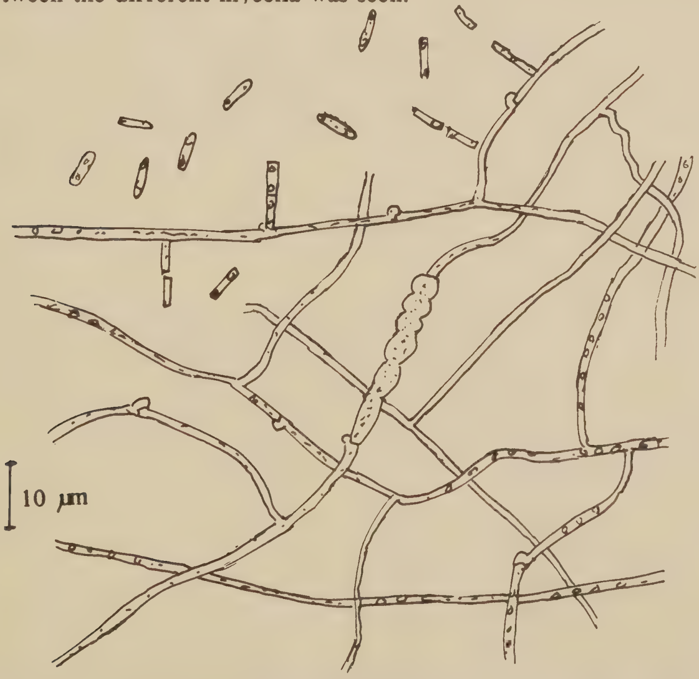

Fig. 11. Hyphae and arthrospores in Pholiota spumosa (GB 884).

CULTURE CHARACTERS (GB 884): Growth slow, dishes covered in five - six weeks. Advancing zone even, appressed (Fig. 2 A). Aerial mycelium

absent. Reverse unchanged. Hyphae narrow, only 1 - 2 μm wide, regularly branched, with a clamp at most septa. Arthrospores (5 - 10 x 2 μm) occur, formed by short, single branches (Fig. 11). No chlamydospores found.
CODE: 2ab, 3c, 7, 35, 36, 38, 45 -46, 49, 55, 60, 63.
OXIDASE REACTIONS: Positive reactions are noted for syringaldazine, guaiac, guaiacol, p-Cresol, L-Tyrosine, but all rather weak.

Pholiota mixta (Fr.)Sing.

MATERIAL:
GB 141/on soil in coniferous forest/Sweden, Vg, Göteborg (SJ 80165).
GB 948/on soil in coniferous forest/Sweden, Vg, Länghem (SJ 83099).
GB 1302/on soil in coniferous forest/Sweden, Vg, St. Mellby. (SJ 84110)

Tab. 9 Polarity tests in *Pholiota mixta.*

	GB 141/2	GB 141/3	GB 141/4	GB 141/5	GB 141/6	GB 141/7	GB 141/8	GB 141/9	GB 141/10
GB 141/1	-	+	+	-	-	+	+	+	-
GB 141/2		-	+	-	+	-	-	-	+
GB 141/3			+	-	-	-	-	-	-
GB 141/4				+	-	+	-	-	+
GB 141/5					-	-	-	-	-
GB 141/6						-	-	-	-
GB 141/7							-	-	-
GB 141/8								-	-
GB 141/9									-

	GB 1302/2	GB 1302/3	GB 1302/4	GB 1302/5	GB 1302/6	GB 1302/7	GB 1302/8
GB 1302/1	+	-	-	-	-	-	+
GB 1302/2		+	-	+	+	-	+
GB 1302/3			+	-	-	+	-
GB 1302/4				-	+	-	+
GB 1302/5					-	-	+
GB 1302/6						+	-
GB 1302/7							+

	GB 948/2	GB 948/3	GB 948/4	GB 948/5	GB 948/6	GB 948/7	GB 948/8	GB 948/9	GB 948/10
GB 948/4	-	+	+	+	+	+	+	+	+
GB 948/7		+	+	+	+	+	+	+	+
GB 948/1			-	-	-	-	-	-	-
GB 948/2				-	-	-	-	-	-
GB 948/3					-	-	-	-	-
GB 948/5						-	-	-	-
GB 948/6							-	-	-
GB 948/8								-	-
GB 948/9									-

POLARITY: Three polarity tests are performed (Tab. 9). The pairing table of GB 141 fits a tetrapolar pattern. However, isolate nr 5 does not form clamps with any of the other isolates. GB 948 seems to be clearly bipolar, without any failures. In GB 1302, however, the pairing table could not be explained without amphithallic tetrapolarity. If 1, 5 = A1B1; 4, 7 = A1B2; 3, 6 = A2B1; 8 = A2B2+A2B1; 2 = A2B2+A1B2, there are no failures. Other interpretations seem to be improbable.

INTERCOMPATIBILITY: The three specimens have been tested with each other and are found to be completely interfertile.

CYTOLOGY: Heterocytic. The spores are binucleate, terminal cells of ss-mycelia multinucleate, other cells seemingly most binucleate. In a secondary mycelium only dicaryotic cells were seen.

CULTURE CHARACTERS (GB 948): Growth moderately rapid, dishes covered in four weeks. Advancing zone even, appressed. Aerial mycelium absent (Fig. 2 B). Reverse unchanged. Hyphae 1 - 3 µm wide, a few with somewhat wider with slight moniliform swellings, regularly branched, with a clamp at most septa. The mycelium is identical in appearance with that of P. spumosa, but no accessory spores seen.

CODE: 2ab, 3c, 26e, 32, 36, 38, 44, 49, 56, 59, 63.

OXIDASE REACTIONS: Positive reactions are noted in all tests, rapid and strong with syringaldazine, guaiac and guaiacol, but very weak with L-Tyrosine.

Pholiota mixta is very similar to *P. spumosa* in most characters and the two species are undoubtly closely related. Several interfertility tests between them have been performed, but none of the matings led to clamp formation.

Pholiota lenta (Fr.)Sing.

MATERIAL:

GB 82/*Fagus* forest/Sweden, Skåne, Anderslöv (SJ 79228).
GB 1060/litter/Sweden, Skåne, Degeberga (SJ 83127).

Tab. 10. Polarity tests in *Pholiota lenta.*

	GB 82/2	GB 82/3	GB 82/4	GB 82/5	GB 82/6	GB 82/7	GB 82/8	GB 82/9	GB 82/10
GB 82/1	+	-	+	-	-	+	-	-	+
GB 82/2		-	-	+	-	-	-	(+)	-
GB 82/3			-	-	-	-	-	+	-
GB 82/4				+	-	-	-	+	-
GB 82/5					-	+	+	-	+
GB 82/6						-	+	+	-
GB 82/7							-	+	-
GB 82/8								+	-
GB 82/9									-

	GB 1060/2	GB 1060/3	GB 1060/4	GB 1060/5	GB 1060/6	GB 1060/7	GB 1060/8	GB 1060/9	GB 1060/10
GB 1060/1	-	+	-	-	-	-	-	+	-
GB 1060/2		+	-	-	-	-	-	+	-
GB 1060/3			-	-	+	+	-	-	-
GB 1060/4				-	-	-	+	-	-
GB 1060/5					+	-	+	-	-
GB 1060/6						-	-	+	-
GB 1060/7							-	+	-
GB 1060/8								-	+
GB 1060/9									-

(+) means only a few clamps seen.

POLARITY: The two available specimens are tested (Tab. 10). Amphithallic tetrapolarity is indicated in the pairing tables of the two specimens studied:

GB 82. The most probable explanation is: 2, 4, 7, 10 = A1B1; 1, 5 = A2B2; 3 = A1B2; 6 = A1B1+A2B1; 8 = A1B1+A1B2; 9 = A2B2+A2B1. This interpretation yields 5 failures. There may be other interpretations but in that case the number of failures is higher.

GB 1060. If 1, 2, 6, 7 = A1B1; 3, 9 = A2B2; 8 = A1B2; 4, 5, 10 = A2B1, there is a regular tetrapolar pattern without failures.

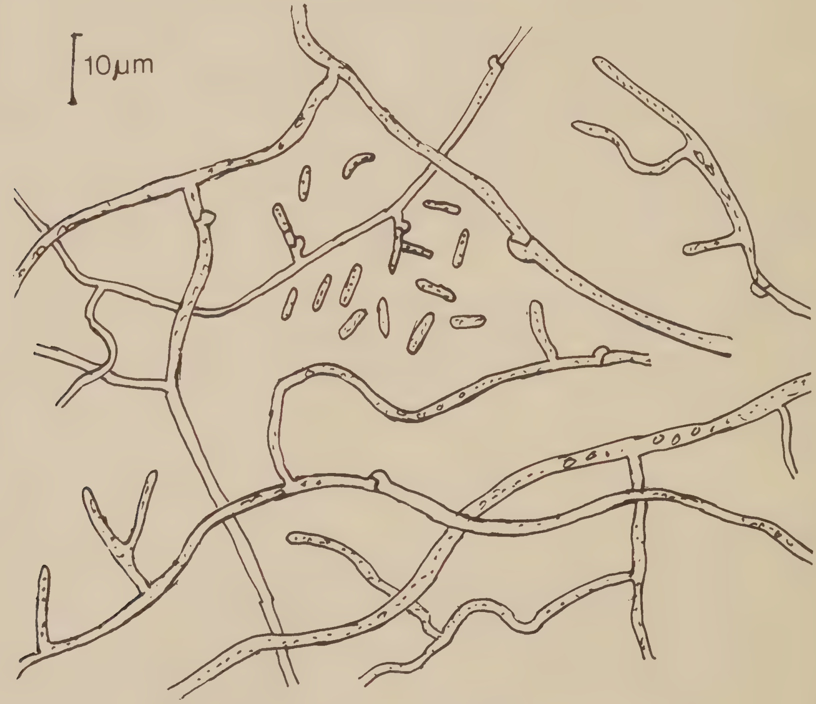

Fig. 12. Hyphae and arthrospores in Pholiota lenta (GB 1060).

INTERCOMPATIBILITY: The two specimens are completely compatible with each other.

CYTOLOGY: Astatocoenocytic behaviour is established. Most cells in ss-mycelia contain two nuclei but some of them, also intercalary cells, are plurinucleate with 5 - 10 nuclei. In a secondary mycelium except normally binucleate, clamped hyphae also pluri- or multinuclear cells in wide hyphae without clamps are seen.

CULTURE CHARACTERS (GB 1060): Growth slow, dishes covered in five weeks. Advancing zone even or somewhat fringed, appressed. Aerial

mycelium absent (Fig. 2 C). Reverse unchanged. Hyphae 1,5 - 4 μm wide, ordinarily branched, with a clamp at most septa. Arthrospores (5 - 10 x 2 μm) occur. Only a few, somewhat wider hyphae with slight irregular swellings seen. No chlamydospores found. (Fig. 12).
CODE: 1 (2b), 3c, 7, 34, 36, 38, 45, 49, 54, 60, 63.
OXIDASE REACTIONS: a weak positive reaction with L-Tyrosine noted, all other tests were negative.

Pholiota lubrica (Pers.:Fr.)Sing.

MATERIAL:
GB 508/litter/Sweden, Västergötland, Halleberg (SJ 82140).
GB 881/*Picea*/Sweden, Jämtland, Mörsil (SJ 83055).
GB 1293/Austria (M.Moser as *Pholiota decussata*).
GB 1495/Sweden, Medelpad, Selånger (J.O.Tedebrand).
POLARITY: Only GB 881 and GB 1495 are tested regarding their polarity. In both specimens amphithallic tetrapolarity is showed (Tab. 11).

Tab. 11. Polarity tests in *Pholiota lubrica*.

	GB 881/2	GB 881/3	GB 881/4	GB 881/5	GB 881/6	GB 881/7
GB 881/1	–	–	–	–	–	–
GB 881/2		–	–	–	–	+
GB 881/3			–	+	–	+
GB 881/4				–	–	+
GB 881/5					–	+
GB 881/6						+

	GB 1495/2	GB 1495/3	GB 1495/4	GB 1495/5	GB 1495/6	GB 1495/7	GB 1495/8
GB 1495/1	–	–	+	+	+	+	+
GB 1495/2		–	+	+	+	+	+
GB 1495/3			+	+	+	+	+
GB 1495/4				–	–	–	+
GB 1495/5					–	–	+
GB 1495/6						–	–
GB 1495/7							–

GB 881: The best interpretation is: 2, 4, 6 = A2B2; 1 = A1B2; 5 = A2B1; 7 = A1B1+A1B2; 3 = A2B2+A1B2. One failure (1 x 5).

GB 1495: 1, 2, 3 = A1B2; 4, 5, 6, 7 = A2B1, 8 = A1B1+A1B2. Two failures with this interpretation (8 x 6, 8 x 7).
INTERCOMPATIBILITY: GB 508, 881, 1293 are tested with each other and were found to be completely interfertile. However, GB 1495 was not compatible with any of the others. The basidiocarps of this collection appeared strikingly yellow ("forma *lutea*") and it seems probable that it represent a separate species. This will be discussed later.
CYTOLOGY: Astatocoenocytic. In ss-mycelia the number of nuclei is very variable (2 - 15 are noted). Also in secondary mycelia with clamps a number of multinucleate (5 - 15) cells are found. These are wider than normal cells and lack clamps at the septa.
CULTURE CHARACTERS (GB 1293): Growth moderately rapid or slow, dishes covered in four or five weeks. Advancing zone even, appressed.

Aerial mycelium absent (Fig. 2 D). Hyphae 2 - 4 μm wide, regularly branched, with a clamp at most septa, in appearance identical with *P. lenta*. Arthroconidia (5 - 10 x 2 μm) occur. No chlamydospores seen.
CODE: 1 (2), 3c, 7, 34, 36, 44-45, 49, 54, 60, 63.
OXIDASE REACTIONS: A weak positive reaction noted with guaiac, otherwise negative.

Tab. 12. Interfertility test between *P. lubrica* and *P. lenta*.

		GB 1289			
		1	2	3	4
GB 881	1	–	–	+	–
	2	–	–	–	+
	3	–	–	–	–
	4	–	–	+	–

In most characters, both morphological and in culture studies, *Pholiota lubrica* is identical with *P. lenta* and without doubt the two species are very closely related. The most evident difference seems to be the pigmentation of the basidiocarps. Some intercompatibility tests have been performed between different strains of *P. lubrica* and *P. lenta*. Four isolates of *lenta* (GB 507) were mated with four each from GB 508 and GB 881. Clamps did not appear in any dish and a distinct barrier was always formed. But in an interfertility test between GB 881 and another specimen of *P. lenta* (GB 1289) clamps were formed in three cases (Tab. 12). This confirms their close relatioship but is not a reason enough to consider them conspecific. Interfertility tests have also been made between *P. lubrica* and *P. mixta* but they were, as expected, negative.

Pholiota scamba (Fr.)Mos.

MATERIAL:
GB 1221/*Picea*/Sweden, Jämtland, Mörsil, Sällsjö (SJ 84057).
GB 1710/*Picea*/Sweden, Västergötland, Hindås (SJ 86043).
POLARITY: A polarity test was performed with GB 1221. The pairing table fits a tetrapolar pattern: 1, 5 = A1B1; 3, 6 = A2B2; 2 = A1B2; 4 = A2B1 (Tab. 13).
INTERCOMPTATIBILITY: The two specimens are completely compatible.
CYTOLOGY: Heterocytic. Several cells of ss-mycelia are multinucleate (- 15 nuclei) and wider than other cells. In ps-mycelia only binucleate cells are seen.

Tab. 13. Polarity test in *Pholiota scamba.*

	GB 1221/2	GB 1221/3	GB 1221/4	GB 1221/5	GB 1221/6
GB 1221/1	–	+	–	–	+
GB 1221/2		–	+	–	–
GB 1221/3			–	+	–
GB 1221/4				–	–
GB 1221/5					+

CULTURE CHARACTERS (GB 1221): Growth slow, dishes covered in six weeks. Advancing zone even, appressed. Aerial mycelium absent.(Fig. 2 F). Reverse unchanged. Hyphae 1 - 4 µm wide, regularly branched, with a clamp at all septa. Irregular or moniliform swellings (- 10 µm wide) frequently occur (Fig. 13), probably some of them may serve as chlamydospores.

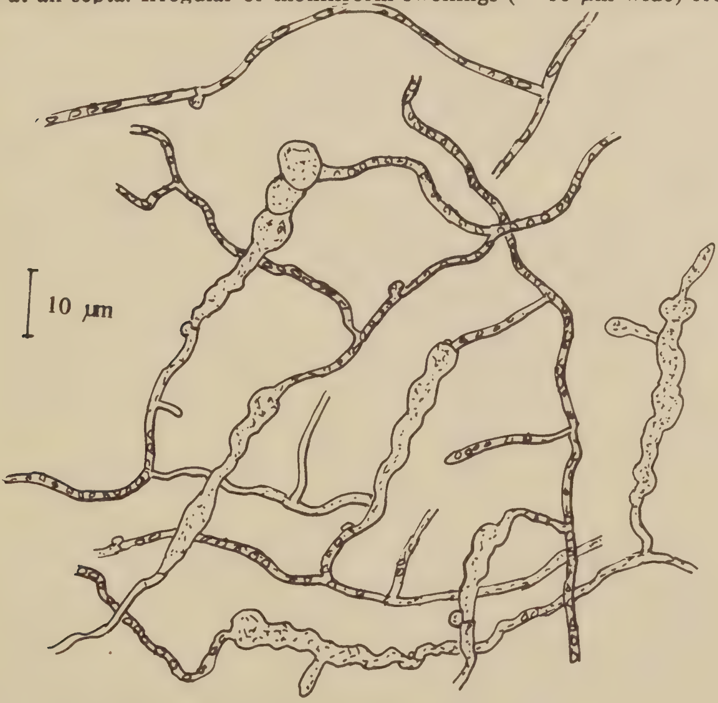

Fig. 13. Hyphae in Pholiota scamba (GB 1221).

Arthrospores not seen in any isolate.

CODE: 2ab, 3c, 26, 34?, 36, 38, 46, 49, 55, 60.

OXIDASE REACTIONS: A strong positive reaction was noted in all tests.

Pholiota gummosa (Lasch)Sing.

MATERIAL:
GB 1254/buried wood/Sweden, Halland, Tjolöholm (SJ 84095).
GB 1295/buried wood/Sweden, Västergötland, Angered (SJ 84163).
GB 1300/*Pinus* bark/Sweden, Västergötland, Bergum (SJ 84164).
GB 1327/buried wood/Sweden, Halland, Kungsbacka (SJ 84180).

POLARITY: The first three specimens are tested regarding their polarity (Tab. 14). The pairing tables show several irregularities and are difficult to interpret with certainty. Amphithallic tetrapolarity is the only possible explanation.

Tab. 14. Polarity tests in *Pholiota gummosa*.

	GB 1254/2	GB 1254/3	GB 1254/4	GB 1254/5	GB 1254/6	GB 1254/7
GB 1254/1	–	–	+	+	–	–
GB 1254/2		–	–	–	+	+
GB 1254/3			+	+	–	–
GB 1254/4				–	+	–
GB 1254/5					+	–
GB 1254/6						+

	GB 1295/2	GB 1295/3	GB 1295/4	GB 1295/5	GB 1295/6	GB 1295/7	GB 1295/8
GB 1295/1	(+)	+	–	–	–	+	+
GB 1295/2		–	(+)	–	+	–	–
GB 1295/3			+	–	+	–	–
GB 1295/4				–	–	+	+
GB 1295/5					+	–	–
GB 1295/6						+	–
GB 1295/7							–

	GB 1300/2	GB 1300/3	GB 1300/4	GB 1300/5	GB 1300/6	GB 1300/7	GB 1300/8	GB 1300/9
GB 1300/1	+	–	+	–	(+)	–	+	–
GB 1300/2		+	–	–	–	+	–	+
GB 1300/3			–	–	+	–	+	–
GB 1300/4				+	–	+	–	+
GB 1300/5					–	–	+	–
GB 1300/6						–	–	+
GB 1300/7							+	–
GB 1300/8								+

(+) means only a few clamps seen, limited to the confrontation line.

GB 1254 is best interpreted as follows. 2 = A1B1; 1, 3 = A1B2; 4, 5 = A2B1; 6 = A2B2+A1B2; 7 = A2B2+A2B1. In this interpretation two failures exist:(1 x 7, 3 x 7). Other interpretations yield more failures.

There is one interpretation of GB 1295 without failures: 5 = A1B1; 6 = A2B2; 1, 4 = A1B2; 8 = A2B1; 2, 3, 7 = A1B1+A2B1. However, it is remarkable that three mycelia have the same combination of factors.

GB 1300 is difficult to interpret. The most reasonable interpretation yields five failures: 5 = A1B1; 4 = A2B2; 6 = A1B2; 2 = A1B1+A1B2; 1, 3, 7, 9 = A1B1+A2B1; 8 = A2B2+A2B1.

The failures are 2 x 4, 3 x 4, 2 x 8, 6 x 7, 6 x 8. The interpretation must be considered as theoretical and uncertain, others are possible but yield more failures.

INTERCOMPATIBILTY: Tests have been made between all possible combinations of the 4 specimens. They appeared to be competely intercompatible.

CYTOLOGY: Boidin (1971) reported an astatocoenocytic behaviour in this species. In this investigation, ss-mycelia were found to have a varying

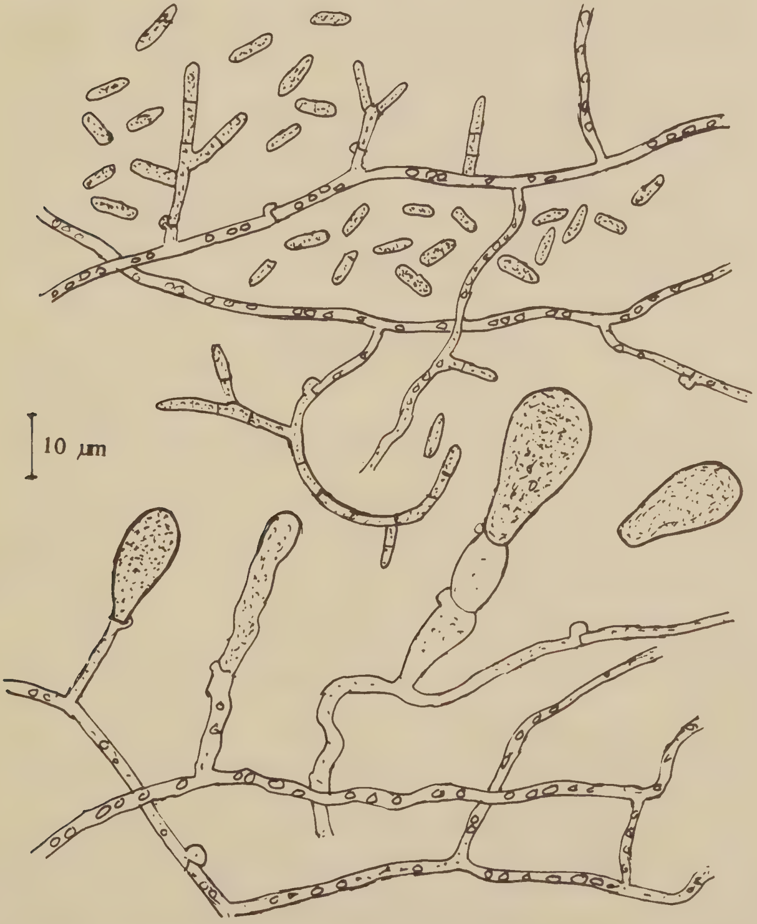

Fig. 14. Hyphae, arthrospores and chlamydospores in Pholiota gummosa (GB 1295).

number of nuclei in the cells, frequently two but many were multinucleate. No multinucleate cells seen with certainty in ps-mycelia.
CULTURE CHARACTERS (GB 1295): Growth moderately rapid, dishes completely covered in three weeks. Advancing zone even, appressed. Mycelium floccose, whitish with brown floccules (very similar to that of *P. squarrosa*) (Fig. 3 A). Reverse somewhat brownish. Hyphae 1,5 - 5 µm wide, regularly branched, with a clamp at most septa, frequently with oil-rich, terminal swellings (chlamydospores, 15 x 30 x 12 - 20 µm), single or in chains. The brown floccules contained numerous arthrospores, 4 - 10 x 2 - 4 µm (Fig. 14).
CODE: 2a, 3c, 26e, 34, 35, 37, 39, 43, 49, 56, 60, 63.
OXIDASE REACTIONS: A weak positive reaction was noted with syringaldazine and guaiacol, other tests were negative.

Pholiota gummosa has been studied in culture. Kühner (1946) made a careful investigation of cultured mycelia and describes the formation of both types of accessary spores. Käärik (1970) states a strong laccase but weak tyrosinase reaction. In this investigation a weak laccase but no tyrosinase reaction was found. The different results may depend on the fact that Käärik used basidiocarp tissue for her tests.

Pholiota graminis (Quél.)Sing.

MATERIAL:
GB 1273/moist ground, close to *Salix* scrub/Sweden, Västergötland, Österplana (SJ 84102).
POLARITY: Unknown, only one ss-mycelium received.
CULTURE CHARACTERS: Growth moderately rapid, the dishes covered in three weeks. Advancing zone even, appressed. Aerial mycelium slightly cottony, brownish in old parts (Fig. 3 B). Reverse brownish. Hyphae 2- 5 µm wide, regularly branched, with a clamp at most septa. Frequent chlamydospores, 15 - 20 x 10 - 15 µm (Fig. 15). No arthrospores seen.
CYTOLOGY: Only ps-mycelia studied. All hyphal cells seemingly binucleate.
CODE: 2ab, 3c, 26e, 34, 37, 39, 43, 49, 56, 58.
OXIDASE REACTIONS: Positive reactions were noted with all reagents.

The culture characters are very similar to those of *P. gummosa*, for instance the conspicuous chlamydospores, which indicate that the species are closely related. Certainly the mycelia on the dishes look very different, very smooth compared with distinctly floccose in *P. gummosa*, but this character seems to be connected with presence or absence of arthrospore formation. The two species also have morphological similarities, especially

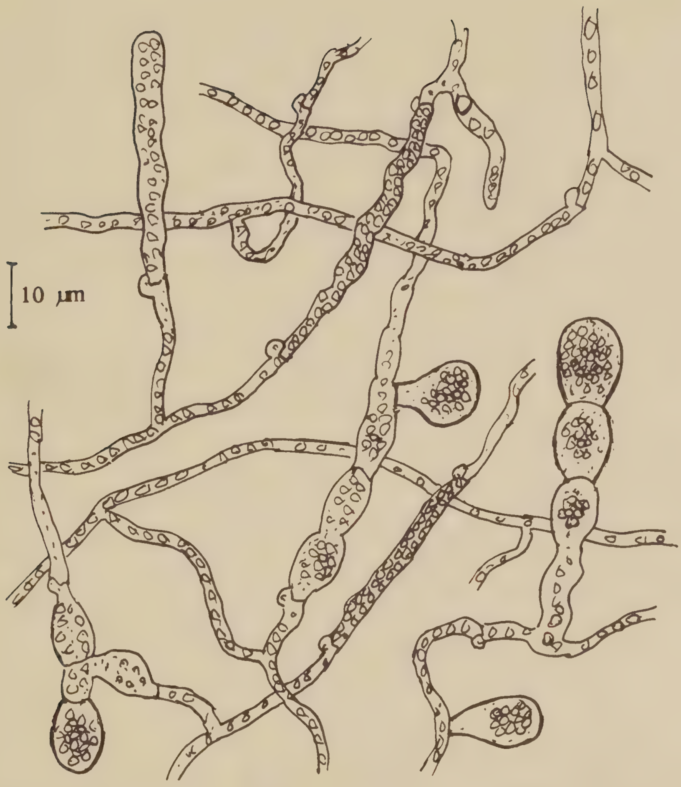

Fig. 15. Hyphae and forming of chlamydospores in Pholiota graminis (GB 1273).

in the shape of the spores. Interfertility tests between GB 1273 and some strains of *P. gummosa* by Buller's phenomen indicate incompatiblity between them.

Pholiota alnicola (Fr.)Sing.

MATERIAL:
GB 174/*Alnus*/Sweden, Göteborg, Botanical Garden (SJ 80194).
GB 1243/*Betula*/Sweden, Åsele Lappmark, Stenbithöjden (SJ 84073).
GB 1341/*Sorbus*/Sweden, Medelpad, Sundsvall (SJ 84097).
GB 1366/*Salix*/Sweden, Scania, Kristianstad (SJ 84132 A).
GB 1763/*Fagus*/Sweden, Scania, Vegeholm (SJ 86071).

POLARITY: GB 174 was tested, but clamps did not appear in any dish. In GB 1763 6 ss-mycelia were tested. It proved to be normally tetrapolar (Tab. 15).

Tab. 15. Polarity test in *Pholiota alnicola.*

	GB 1763/3	GB 1763/4	GB 1763/5	GB 1763/6	GB 1763/7
GB 1763/1	–	–	–	–	+
GB 1763/3		–	–	+	–
GB 1763/4			–	+	–
GB 1763/5				+	–
GB 1763/6					–

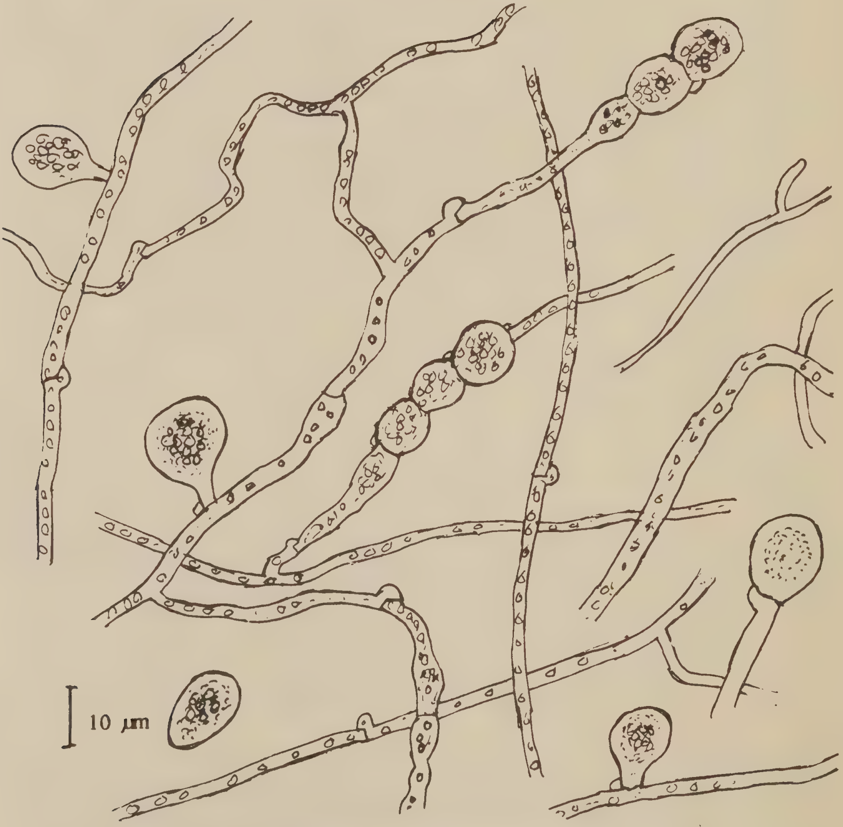

Fig. 16. Hyphae and chlamydospores in Pholiota alnicola (GB 1243).

INTERCOMPATIBILITY: The specimens mentioned have been tested in most possible combinations and were found to be completely intercompatible. It is especially notable that specimens growing on *Sorbus* and *Fagus* were compatible with specimens growing on *Alnus* or *Betula*, as substrate specificity is sometimes used in discussions on species delimitations (cfr *Flammula apicrea* ss. Lge.).

CYTOLOGY (GB 1243): Heterocytic. Cells of ss-mycelia frequently pluri- to multinucleate. All hyphae of the secondary mycelium are regularly clamped.

CULTURE CHARACTERS (GB 1243): Growth very slow, in six weeks three mycelia had reached only 42 - 50 mm from the place of inoculation. Advancing zone appressed, fringed. Aerial mycelium downy - cottony (Fig. 3 E). Reverse somewhat yellowish brown. Hyphae 2 - 5 μm wide, regularly branched, with a clamp at all septa. Numerous large chlamydospores, 15 - 30 x 12 - 15 μm, i all parts of the mycelium (Fig. 16). They arise both apically and as lateral inflations.

CODE: 1, 3c, 26, 34, 37, 39, 47, 49, 54, 60, 61.

OXIDASE REACTIONS: No positive reaction noted.

Pholiota alnicola and *P. pinicola* diverge morhologically from other Pholiotas and therefore appear to take a rather isolated systematic position, and the culture characters emphasize this. The mycelia look rather different from most other species by the rich occurrence of large chlamydospores. *P. alnicola - pinicola* appear to be normally tetrapolar contrary to others, which mostly are amphithallic.

According to Käärik (1965) *P. alnicola* belongs to the group of fungi producing laccase but not tyrosinase.

Pholiota pinicola S.Jacobss.

MATERIAL:
GB 1356/*Pinus*/Sweden, Göteborg, V.Frölunda (SJ 84169).
GB 1359/*Pinus*/Sweden, Västergötland, Sätila (SJ 84158).

POLARITY: 10 ss-mycelia of GB 1359 are tested (Tab. 16). The specimen was normally tetrapolar.

INTERCOMPATIBILITY: The two specimens in culture were found to be compatible.

CYTOLOGY: Not studied but probably heterocytic like *P. alnicola*. The hyphae of the secondary mycelium are not very variable in wideness and always clamped.

CULTURE CHARACTERS (GB 1359): Growth very slow, in six weeks the mycelia only had reached 35 - 37 mm from the place of inoculation. Advancing zone appressed, bayed - fringed. Aerial mycelium downy and whitish in distal (young) parts, patch-wise brownish and subfelty in old parts. (Fig. 3 F). In all other respects, chlamydospores etc, identical with those of *P. alnicola*.

CODE: 1, 3c, 26e, 34, 36, 39, 47, 49, 55, 60, 61.

Tab. 16. Polarity test in *Pholiota pinicola*.

	GB 1359/2	GB 1359/3	GB 1359/4	GB 1359/5	GB 1359/6	GB 1359/7	GB 1359/8	GB 1359/9	GB 1359/10
GB 1359/1	–	–	–	+	–	–	–	–	+
GB 1359/2		–	–	–	–	–	+	+	–
GB 1359/3			–	–	–	–	+	+	–
GB 1359/4				–	–	–	+	+	–
GB 1359/5					–	+	–	–	–
GB 1359/6						–	+	+	–
GB 1359/7							–	–	+
GB 1359/8								–	–
GB 1359/9									–

OXIDASE REACTIONS: No positive reaction noted.

The culture characters of this species are very similar to those of *P. alnicola* and confirm their close relationship.

Pholiota mutabilis (Schaeff.:Fr.)Kummer

MATERIAL.
GB 1304/*Betula*/Sweden, Västergötland, Göteborg (SJ 84172).
POLARITY: 10 ss-mycelia of the specimen GB 1304 were mated in all possible combinations (Tab. 17). The most reasonable interpretation suggests bipolarity, in that case with two failures (1 x 8, 2 x 7).

Tab. 17. Polarity test in *Pholiota mutabilis*.

	GB 1304/2	GB 1304/3	GB 1304/4	GB 1304/5	GB 1304/6	GB 1304/7	GB 1304/8	GB 1304/9	GB 1304/10
GB 1304/1	–	–	+	+	–	+	–	–	+
GB 1304/2		–	+	+	–	–	+	–	+
GB 1304/3			+	+	–	+	+	–	+
GB 1304/4				–	+	–	–	+	–
GB 1304/5					+	–	–	+	–
GB 1304/6						+	+	–	+
GB 1304/7							–	+	–
GB 1304/8								+	–
GB 1304/9									+

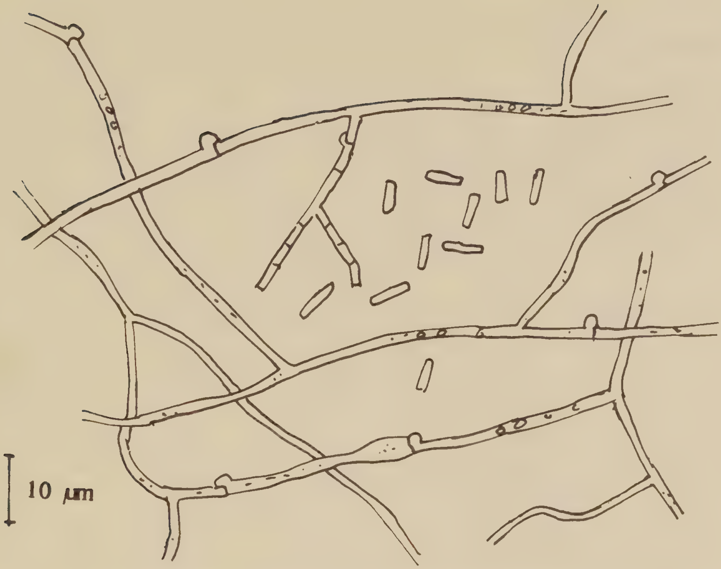

Fig. 17. Hyphae and arthrospores in Pholiota mutabilis (GB 1304).

CULTURE CHARACTERS: Growth slow, dishes covered in five weeks. Advancing zone even, appressed. Aerial mycelium cottony, white (Fig. 3 D). Reverse only weakly brownish. Hyphae 1 - 3 (-4) µm wide, regularly branched, with a clamp at all septa. A rather low number of arthrospores (5 - 10 x 2 µm) are formed in the aerial mycelium. The hyphae are very little differeniated, only occasionally slight intercalary swellings (2 - 5 µm wide) appear (Fig. 17).
CODE: 2ab, 3c, 7, (26), 35, 36, 38, 45, 49, 54, 59.
OXIDASE REACTIONS. Strong positive reaction noted with all reagents.

Pholiota mutabilis has long been placed in the genus *Kuehneromyces*. However, Kühner (1980) has pointed out that there actually are no real differences between this and other species of *Pholiota* and therefore proposes a reunion of *Kuehneromyces* with *Pholiota*. The culture characters noted are normal for the genus and do not support generic separation. The bipolarity must be confirmed by additional investigations, it may be an artifact. Vandendries & Brodie (1933) reported this species to be tetrapolar. Bipolarity is apparently uncommon in *Pholiota*, with certainty only known for *P. jahnii*.

The strong reaction both for laccase and tyrosinase was noted also by Käärik (1970).

Pholiota lignicola (Peck)S.Jacobss. comb. nov.
(basionym: *Agaricus lignicola* Peck, N.Y.State Cab., Ann.Rep. 23:91, 1872)

MATERIAL:
GB 1908/coniferous wood/Sweden, Göteborg, Skatås (SJ 87001).
POLARITY: The polarity test indicates that the species is normally tetrapolar (Tab. 18). If 1, 2 = A1B1; 4, 5, 8 = A2B2; 3 = A1B2; 7 A2B1; 6 = A2B2+A1B2, there are no failures.

Tab. 18. Polarity test in *Pholiota lignicola.*

	GB 1908/2	GB 1908/3	GB 1908/4	GB 1908/5	GB 1908/6	GB 1908/7	GB 1908/8
GB 1908/1	–	–	+	+	–	–	+
GB 1908/2		–	+	+	–	–	+
GB 1908/3			–	–	–	+	–
GB 1908/4				–	+	–	–
GB 1908/5					+	–	–
GB 1908/6						+	+
GB 1908/7							–

CYTOLOGY: Not studied. Only clamped hyphae are seen in the secondary mycelium.
CULTURE CHARACTERS: Growth slow, dishes covered in six weeks. Advancing zone even, appressed. Aerial mycelium sparse, downy. Reverse pale yellowish. Normal, straight hyphae 1,5 - 4 μm wide, regularly branched and with a clamp at most septa, but a great part of the hyphae are very irregular in shape and (mostly 5 - 10 μm wide) with numerous swellings, often with a moniliform appearance (Fig. 18). Many of the swellings serve as chlamydospores. No arthrospores are seen.
CODE: 2a, 3c, 26e, 34, 36, 39, 46, 49, 55, 60, 63
OXIDASE REACTIONS: Positive but rather weak reactions were noted with syringaldazine, 1-naphtol and guaiac, otherwise negative.

This species was earlier known as *Kuehneromyces vernalis* (Peck)Singer & Smith, which name, however, is illegitimate because the basionym *Agaricus vernalis* Peck is a later homonym of *Agaricus vernalis* Bolton(Redhead 1984). It is frequently placed in *Kuehneromyces* close to *mutabilis*, depending on similarities in microscopical characters as the prominent germ-pore in the spores and the absence of chrysocystidia. The cultural characters of *P. lignicola* are very different from those of *P. mutabilis* and it is obvious that the two species are not closely related.

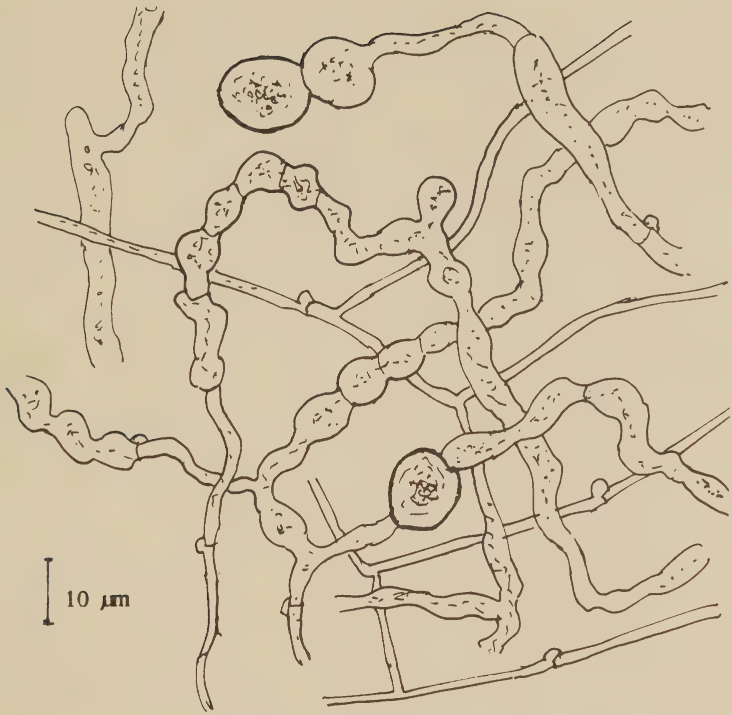

Fig. 18. Hyphae in Pholiota lignicola (GB 1908).

Pholiota albocrenulata (Peck)Sacc.

MATERIAL:
GB 1851/*Acer*/USA (CBS 228.30).
POLARITY: Unknown.
CULTURE CHARACTERS: Growth slow, dishes covered in five weeks. Advancing zone even, appressed. Aerial mycelium absent. Hyphae generally 3 - 6 µm wide, regularly branched, without clamps. Actively growing, terminal hyphae frequently moniliform with 5 - 10 µm wide swellings (Fig. 19). No accessory spores seen.
CODE: 1, 6, 26, 32, 37, 45, 49, 54.
OXIDASE REACTIONS: No positive reaction noted with any reagent.

The secondary mycelium of *Pholiota albocrenulata* is normally clamped. The culture CBS 228.30 is apparently very old (originally collected by I.Mounce) and lacks clamps. The reason for the absence of

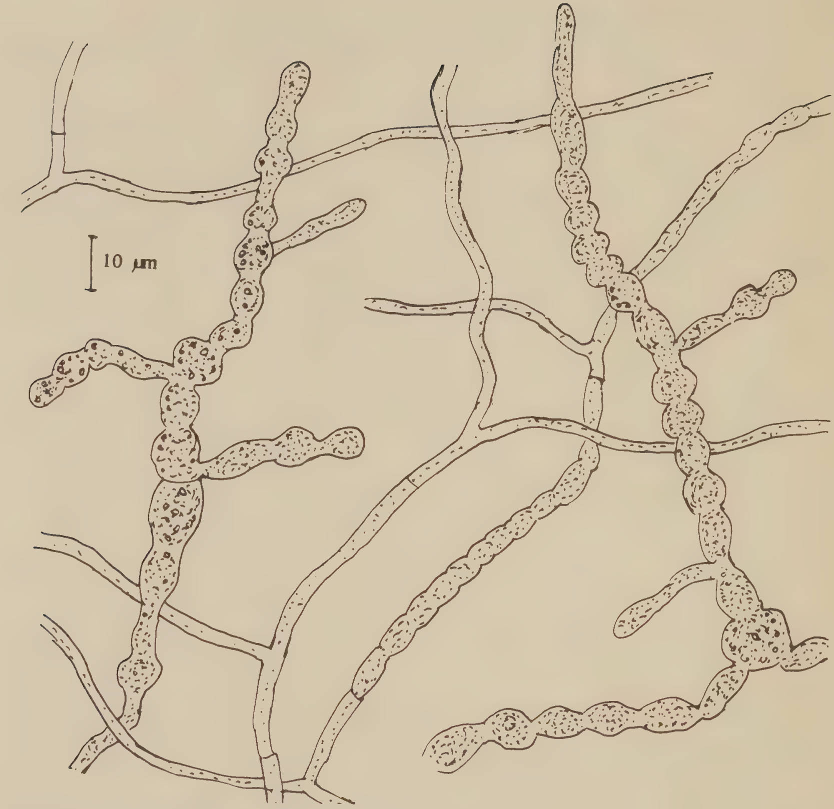

Fig. 19. Hyphae in Pholiota alnocrenulata (GB 1851).

clamps is probably senescence. P. albocrenulata (often placed within Stropharia) differs in some characters, e.g. pigmentation and the spores, from other species of Pholiota and might perhaps better be transferred to a genus of its own. However, there are no special microcharacters noted which give additional support for this.

Gymnopilus junonius (Fr.)Orton

MATERIAL:
GB 1311/*Betula*/Sweden, Bohuslän, Hönö (SJ 84074).
POLARITY: Unknown, only one ps-mycelium studied.
CULTURE CHARACTERS: Growth moderately rapid, dishes covered in four weeks. Advancing zone somewhat fringed. Aerial mycelium downy, whitish. Hyphae 2 - 5 µm wide, regularly branched, with lamps at most septa. Piriform to globose chlamydospores (10 -20 x 7 - 15 µm) are rather

numerous (Fig. 20). No arthrospores seen.
CODE: 2a, 3c, 26e, 34, 36, 44, 49, 54.
OXIDASE REACTIONS: A weak positive reaction noted with guaiac and 1-Naphtol, otherwise negative.

The culture characters noted correspond well with those of species belonging to Pholiota. Gymnopilus is separated from Pholiota by having rough spores, which is easily seen also in a light microscope, and the absence of chrysocystidia. The two genera have the pigments and ecology in common and are undoubtly related.

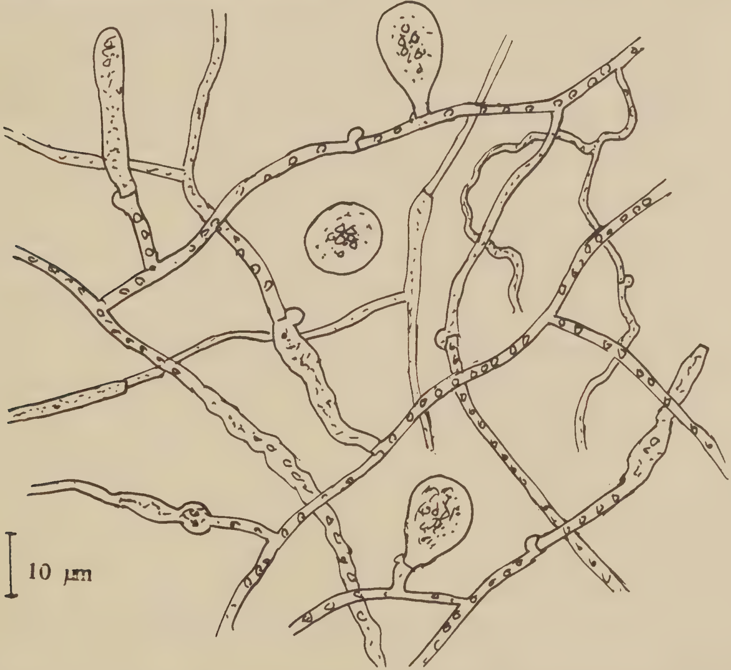

Fig. 20. Hyphae and chlamydospores in Gymnopilus junonius (GB 1311).

CONCLUSIONS

The culture characters of this investigation are part of a taxonomic work on Pholiota in northern Europe which will include morphological and ecological data. Culture characters, until now, have been rarely used in the taxonomy of agarics, though regularly used by mycologists in Aphyllophorales. No doubt cultural studies add many valuable characters for a better understanding of relationships between species, groups of species or genera, but of course, the results must be used with care, as the infraspecific variation is not well documented.

In *Pholiota* and allied genera there are clear differences between species in several characters as the general appearance of the hyphae, growth rate, type of and frequency of accessory spores, presence or absence of laccase/tyrosinase etc. The reliability of a character increases with the number of studied isolates. It is desirable to sample several cultures of each species, which, however, not always has been possible.

Some natural groups of closely related species are easily distinguished in *Pholiota*, e.g. the *adiposa* and the *lubrica* groups. That the species in these groups are closely related is quite obvious as they have many basidiocarp characters in common. As expected closely related species in culture also have most characters in common. For instance, all members of the *adiposa* group have a slow growth rate and all form numerous arthrospores in aerial mycelia and chlamydospores in submerged parts of the mycelia. The *lubrica* group is characterized by moderately to slow growth rate and a rather simple appearance of the hyphae. Arthrospores are formed in some species but chlamydospores are absent or rare.

However, there are also divergences. *Pholiota highlandensis*, judging from basidiocarp morphology a typical member of the lubrica group, differs from the others in some respects. It is rather difficult to culture, only a very low number of spores germinate on common malt agar (the other species are easily cultured) but when germinated, the growth is rather rapid. The differences are probably connected with the specialized ecology of this species.

Some species, e.g. *P. tuberculosa* and *P. heteroclita*, deviate in many characters from others and therefore appear isolated systematically. *Pholiota squarrosa* has some characters, e.g. the chlamydospores and growth rate, similar to *P. gummosa* - *P. graminis* and may therefore be related to these species, though they generally are placed in a different subgenus (*Flammula*) based on their morphological characters. In any case, it is obvious that the old division of *Pholiota* into two subgenera *Pholiota* and *Flammula* is not natural. *P. mutabilis* and *P. lignicola* are earlier generally placed in a separate genus, *Kuehneromyces*. The characters in culture reveal that the two species are not closely related and apparently there do not exist any tenable reason to maintain *Kuehneromyces*. *Gymnopilus junonius* has characters which correspond with many species of *Pholiota* and the culture study supports a close relationship between the two genera. Owing to the rough spores *Gymnopilus* often is supposed to be related to *Cortinarius* rather than *Pholiota*.

The result of the oxidase drop tests indicate differences also between closely related species regarding occurence of laccase and tyrosinase. It is difficult to distinguish any pattern. Some results do not correspond with earlier published reports and it is probable that the occurence of the enzymes vary depending on environmental circumstances. Reports on absence or presence of laccase or tyrosinase therefore seem to be of restricted taxonomic value.

Several polarity tests were in *Pholiota* difficult to interprete, due to unexpected irregularities. Tetrapolarity is the normal state within the genus, only one species (*P. jahnii*) seems to be bipolar. Amphithallism is a common reason to irregularities in the polarity tests, which corresponds with earlier results (cfr Ginns 1974). Many species have an astatocoenocytic behaviour in their cytology.

The intercompatibility tests have proved to be very valuable for taxonomical studies in *Pholiota*. Several species complexes investigated with this method included some which were, on the basis of morphological characters, essentially unresolvable.

In most cases matings between isolates of the same species have resulted in the formation of clamps in almost 100 % of the crosses, because of the multiple allele effect. Sometimes positive matings do not occur in all crosses. A reasonable explanation is deficient monokaryons. In many cases collections with slight morphological differences which possibly could be united within the same species, were completely incompatible and, hence, regarded as distinct species.

Generally all crosses between closely related species are negative. In some cases a few positive pairings have appeared between closely related species, e.g. between *P. lenta* and *P. lubrica*. This suggests that the two taxa involved have not been completely genetically isolated. Also between *P. adiposa* from the USA and *P. limonella* from Sweden some positive pairings have appeared. However, the species concepts in the *adiposa* complex is rather complicated (Jacobsson 1987).

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Scientific Names in the Endogonales, Zygomycotina

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ABSTRACT

Analysis of scientific names of 150 species in the Endogonaceae suggested correction of one generic name and 10% of the specific epithets that were not in accordance with the rules of the International Code of Botanical Nomenclature. It is suggested that authors be more cognizant of etymology and pay more attention to the rules of the Code when naming new species in order to have more uniformity in nomenclature of this important group of fungi.

The Endogonales, with one family, Endogonaceae, is composed of seven genera and 150 described species. Although some species probably will be relegated to synonyms, there probably will be a proliferation of new species in future years. To describe new fungal species, knowledge of nomenclature, a word of Latin origin or its Greek equivalent, onomatology (Leal, 1972), is necessary. Nomenclature mainly involves studies on the interpretation of the International Code of Botanical Nomenclature, rules of Greek and Latin etymology and Latin grammar. Etymology (Gr. *etymon*, the true, original or literal meaning of a word and Gr. *logos*, science of) is a branch of linguistics that studies the origin or derivation of words.

Under Principle V. of the International Code of Botanical Nomenclature (ICBN) (Stafleu et al., 1983), scientific names of plants and fungi are Latin or treated as Latin regardless of their derivation. The name of a genus is a singular noun and the first letter is always capitalized. It may be taken from many sources but its derivation is based on regulations established by ICBN (Stafleu et al., 1983).

Genera

Excluding *Glomus*, (Latin, a ball of yarn, gender neuter) all other genera of the Endogonaceae are feminine and are compound or hybrid words: *Endogone*, Gr. *endo*, inside, and Gr. *gone*, seed; *Sclerocystis,* Gr. *skleros*, hard, and Gr. *kystis*, bladder; *Gigaspora*, Gr. *gigas*, giant, and Gr. *spora*, spore; *Acaulospora*, Gr. *a*, without, Gr. *kaulos*, stem, and Gr. *spora*, spore; *Entrophospora*, Gr. *en*, within, Gr. *trophos*, nourished or reared, and Gr. *spora*, spore; *Scutellospora*, L. *scutellum*, small shield, and Gr. *spora*, spore. *Scutellospora* is a hybrid word formed from two different languages. According to recommendation 75A.2 of ICBN (Staffleu et al., 1983), the gender in generic compound names is determined by the gender of the last word. If the termination is altered, however, the gender should agree with it. In the formation of compound names, the recommendation 73G should be followed also (Stafleu et al., 1983). The prefixes a– and en– are connected to the stem of the first word. In *Scler-o-cystis, Acaul-o-spora* and *Entroph-o-spora*, a connecting vowel –o– is inserted before a consonant in the second word if the first word stem is Greek and ends in a consonant (*scler*–, *acaul*– and *entroph*–). In *Gigaspora*, the stem of the first word is *gigas*. In this case the last vowel of the stem may be preserved just as it was in the prefix *Endo*–to form *Endogone*. In *Scutellospora*, the recommendation is that an –i–, and not an –o– be inserted between the two consonants since *scutellum* is a Latin word. Thus, the correct spelling for the genus *Scutellospora* is *Scutellispora*. Article 73.8 (Stafleu et al., 1983) stipulates that the use of an incorrect compounding form in an epithet is treated as an orthographic error to be corrected (see Rec. 73G).

Specific Epithets

Most of the specific epithets in the Endogonaceae are adjectives (Table 1) and are found in Schenck & Pérez (1988), the *Endogone* species in Gerdemann & Trappe (1974) and Tandy (1975), and other new species in Blaszkowski (1988), Sieverding, Chaverri & Rojas (1988), Sieverding (1988), and Spain, Sieverding & Schenck (1989). Most Greek and Latin words in the etymology portion of Table 1 were obtained from Lewis and Short (1907), Brown (1956), Nybakken (1960), Ayers (1977) and Simpson (1979). Examples of compound specific epithets in the Endogonaceae that were formed in a similar manner to *Scutellispora*, with the first word in Latin, are *Sclerocystis clav-i-spora, Glomus magn-i-caule* and 18 other specific epithets (Table 1). In *Sclerocystis pachy - caulis* and *Acaulospora myrio-carpa*, the last vowels of the Greek stem were maintained as in compounding the word *Giga-spora*. For *Glomus microaggregatum*, the recommendation is to form the epithet *micraggregatum*, as in the genus *Micranthus*, small flowered, because the second word starts with a vowel. The specific epithet of *Gigaspora alborosea* is a pseudocompound formed by two adjectives and the adjective in a non final position (*albo*) appears as a word with a case ending not as a modified stem, *alborosea*, meaning pink with white.

The specific epithet may be an adjective, a present participle, a noun, or a combination of an adjective and noun or two adjectives. It may be taken from any source but must be based on regulations (Stafleu et al., 1983). Present participles follow the normal declension rules and must modify nouns like any adjective. According to Houg (1953), all present participles conform to one–ending third–declension and may be compared in the same fashion as adjectives. When specific epithets are adjectives they must agree grammatically – gender, number and case – with the generic name. Specific epithets, when they are nouns, do not necessarily agree grammatically with a generic name. These epithets may be either 1) a noun in apposition or in the nominative case, singular number, or 2) a noun in the genitive case, singular or plural (Stafleu et al. 1983, Article 23.5).

A noun in apposition or a noun in the nominative case, singular number, is found in Acaulospora appendicula, Endogone flammicorona, Glomus pansihalos, G. deserticola, Scutellispora savannicola and *Glomus citricola*, instead of *citricolum*, as found in the original description. The nouns ending in –*cola* as *deserticola, savannicola* and *citricola*, used as specific epithets do not have to change their endings in order to agree with the gender of the genus. Snell & Dick (1971) point out that *Cronartium ribicola* is correct but *Pythium graminicolum* is incorrect. In

Gigaspora margarita, the specific epithet can be either a noun in apposition, *margarita, ae,* pearl or an adjective *margaritus, a, um,* pearly (Gledhill, 1985). The specific epithet of *Scutellispora auriglobа* is formed by L. *aurum* and L. *globus*. Used as a noun, it must be *Scutellispora auriglobus,* not *auriglobа* in order to agree grammatically with *Scutellispora*. As an adjective it is formed by L. *aurum*; L. *globosus, a, um* giving *Scutellispora auriglobosa* as the suggested name for this species (Table 1).

Fifteen specific epithets in the Endogonaceae, which honor individuals, are in the genitive case (Table 1). According to Stafleu et al. (1983) when the patronym ends in a vowel, substantive epithets are formed by adding the genitive inflection appropriate to the gender of the person honored as in *Acaulospora trappei*, for Trappe (masculine) and in *Glomus mosseae*, for Mosse (feminine). When the personal name ends in a consonant, substantive epithets are formed by adding –i– (stem augmentation) plus the genitive inflection appropriate to the gender of the person honored as in *Entrophospora schenckii*, for Schenck (masculine) and *Scutellispora weresubiae*, for Weresub (feminine). Stafleu et al. (1983) do not recommend the dedication of genera to individuals not connected with botany or the natural sciences. This recommendation should be followed also when naming a species.

Glomus manihotis is an example of a noun in the genitive case used to name a species, referring to the host *Manihot*. According to Stafleu et al. (1983) Boehmer and Adamson failed to indicate the gender of *Manihot* when they described the genus. The first author to supply a specific epithet to *Manihot* was Crantz who in 1766 proposed the name *Manihot esculenta*, thus indicating that *Manihot* was feminine. Stearn (1966) stated that *Manihot* is best treated as indeclinable, i.e, as being the same as the nominative in all cases. Based on this recommendation, the correct name for this species is *Glomus manihot* similar to that applied to *Meliola manihot* by Stevens & Tehon (1926). The epithet for *Glomus invermaium* was derived from the locality Invermay. Recommendation 73D (Stafleu et al., 1983) proposes that an epithet derived from a geographical name is preferably an adjective and usually takes the termination *–ensis*, *–(a)nus*, *–inus*, or *–icus*. Art. 73.4 adds that the letters w and y, foreign to classic Latin and k, rare in that language, are permissible in Latin fungal names. Based on this , a more appropriate name for *Glomus invermaium* would be *Glomus invermayanum*. This epithet provides a better notion of the location from which the specific epithet was derived. Similarly, in *Acaulospora gedanensis*, a more appropriate name would be *Acaulospora gdanskensis* named for the Gdansk area. The words formed with the Latinized Greek ending *–oides*, as in the word *bryoides* (moss like), have in nominative singular the same ending in all genders: *bryoides* (m.), *bryoides* (f.), *bryoides* (n.) (Stearn, 1966; Gledhill, 1985). In the Endogonaceae (Table 1), the specific epithets of *Sclerocystis coremioides, Glomus botryoides, G. claroides*, instead of *claroideum*, and *Scutellispora coralloides*, replacing *coralloidea*, are formed with the invariable ending *–oides* regardless of the gender of the genus. Stearn (1966) gives the neuter name *sporocarpium,* sporocarp, that could form the adjective *sporocarpius, a, um* and justify the specific epithet of *Acaulospora sporocarpia*. The specific name of *Acaulospora sporocarpia* is formed from Gr. *spora*, spore and Gr. *karpos*, fruit, giving *spor-o-carpa* (Table 1). Based on etymology the suggested name for *A. sporocarpia* is *A. sporocarpa* formed in the same way as in *Acaulospora myriocarpa*, G. *macrocarpum* and *G. microcarpum* compounded with the adjective *carpus, a, um*. *Glomus intraradices* (Table 1) has the

Table 1. Scientific names in the Endogonaceae: Species names as described, etymology, accentuation and suggested names.[1]

Species name as described	Etymology	Suggested name and accentuation
Acaulospora		*Acaulóspora*
A. appendicula Spain, Sieverding & Schenck	L. *appendicula*, little appendage	*A. appendícula*
A. bireticulata Rothwell & Trappe	L. *bi*; two, twice; L. *reticulatus, a, um*, reticulate	*A. bireticuláta*
A. delicata Walker, Pfeiffer & Bloss	L. *delicatus, a, um*, soft, tender	*A. delicáta*
A. denticulata Sieverding & Toro	L. *denticulatus, a, um*, provided with small teeth	*A. denticuláta*
A. dilatata Morton	L. *dilatatus, a, um*, dilated, expanded	*A. dilatáta*
A. elegans Trappe & Gerdemann	L. *elegans, ans, ans*, elegant	*A. élegans*
A. foveata Trappe & Janos	L. *foveatus, a, um*, pitted	*A. foveáta*
A. gedanensis Blaszkowski	Place Gdansk; *ensis, is, e*	*A. gdanskénsis*
A. gerdemanni Schenck & Nicolson	Honor Dr. Gerdemann, noun m.; *ii*, gen.	*A. gerdemánnii*
A. lacunosa Morton	L. *lacunosus, a, um*, full of hollows	*A. lacunósa*
A. laevis Gerdemann & Trappe	L. *levis, is, e*, smooth (*laevis* erroneously)	*A. láevis*
A. longula Spain & Schenck	L. *longulus, a, um*, dim. of *longus*, long	*A. lóngula*
A. mellea Spain & Schenck	L. *melleus, a, um*, of or belonging to honey	*A. méllea*
A. morrowae Spain & Schenck	Honor Dr. Morrow, noun f.; *iae*, gen.	*A. morrówiae*
A. myriocarpa Spain, Sieverding & Schenck	Gr. *myrios*, numerous, Gr. *karpos*, fruit	*A. myriocárpa*
A. nicolsonii Walker, Reed & Sanders	Honor Dr. Nicolson; noun m.; *ii*, gen.	*A. nicolsónii*
A. polonica Blaszkowski	Place Poland; *icus, a, um*	*A. polónica*
A. rehmii Sieverding & Toro	Honor Dr. Rhem; noun m.; *ii*, gen.	*A. réhmii*
A. rugosa Morton	L. *rugosus, a, um*, wrinkled	*A. rugósa*
A. scrobiculata Trappe	L. *scrobiculatus*, a, um, minutely pitted	*A. scrobiculáta*
A. spinosa Walker & Trappe	L. *spinosus, a, um*,full of thorns	*A. spinósa*
A. splendida Sieverding, Chaverri & Toro	L. *splendidus, a, um*, sparkling, splendid	*A. spléndida*
A. sporocarpia Berch	Gr. *spora*, spore; Gr. *karpos*, fruit	*A. sporocárpa*
A. thomii Blaszkowski	Honor author's son; noun m.; *ii*, gen.	*A. thómii*

[1] *Scientific names are not accented. Accentuation marks provided as a suggestion for pronunciation; m. (masculine); f. (feminine); gen. (genitive), L. (Latin); Gr. (Greek); (ʹ) stressed syllable.*

A. trappei Ames & Linderman	Honor Dr. Trappe; noun m.; *i*, gen.	*A. tráppei*
A. tuberculata Janos & Trappe	L. *tuberculatus, a, um*, with small rounded projections	*A. tuberculáta*
A. undulata Sieverding	L. *undulatus, a, um*, undulatory, wavy	*A. unduláta*
Endogone		*Endógone*
E. acrogena Gerdemann, Trappe & Hosford	Gr. *akros*, at the end; Gr. *genes*, to be produced	*E. acrógena*
E. aggregata Tandy	L. *aggregatus, a, um*, clustered	*E. aggregáta*
E. alba (Petch) Gerdemann & Trappe	L. *albus, a, um*, white, whitish	*E. álba*
E. crassa Tandy	L. *crassus, a, um*, thick	*E. crássa*
E. flammicorona Trappe & Gerdemann	L. *flamma*, a flame; L. *corona*, crown	*E. flammicoróna*
E. incrassata Thaxter	L. *incrassatus, a, um*, thickened	*E. incrassáta*
E. lactiflua Berkeley & Broome	L. *lac*, *lactis*, milk; L. *fluo*, to flow	*E. lactíflua*
E. multiplex Thaxter	L. *multiplex* (*multus/plico*), having many folds	*E. múltiplex*
E. oregonensis Gerdemann & Trappe	Place Oregon; *ensis, is, e*	*E. oregonénsis*
E. pisiformis Link ex Fries	L. *pisum*, pea; L. *forma*, shape	*E. pisifórmis*
E. reticulata Tandy	L. *reticulatus, a, um*, reticulate	*E. reticuláta*
E. stratosa Trappe & Gerdemann	L. *stratosus, a, um*, layered	*E. stratósa*
E. tuberculosa Lloyd	L. *tuberculosus, a, um*, provided with small swellings	E. *tuberculósa*
E. verrucosa Gerdemann & Trappe	L. *verrucosus, a, um*, warty	*E. verrucósa*
Entrophospora		*Entrophóspora*
E. colombiana Spain & Schenck	Place Colombia; *anus, a, um*	*E. colombiána*
E. infrequens (Hall) Ames & Schneider	L. *infrequens, ens, ens*, rare	*E. ínfrequens*
E. schenckii Sieverding & Toro	Honor Dr. Schenck; noun m.; *ii*, gen.	*E. schénckii*
Gigaspora		*Gigáspora*
G. albida Schenck & Smith	L. *albidus, a, um*, whitish	*G. álbida*
G. candida Bhattacharjee, Mukerji, Tewari & Skoropad	L. *candidus, a, um*, of a shinning, dazzling white	*G. cándida*
G. decipiens Hall & Abbott	L. *decipiens, ens, ens*, deceiving, deceptive	*G. decípiens*
G. gigantea (Nicol. & Gerd.) Gerdemann & Trappe	L. *giganteus, a, um*, of or belonging to the giants	*G. gigantéa*

G. margarita Becker & Hall	*L. margaritus, a, um*, pearly	*G. margaríta*
G. ramisporophora Spain, Sieverding & Schenck	L. *ramus*, branch; Gr. *spora*, spore; Gr. *phoros*, bear	*G. ramisporóphora*
G. rosea Nicolson & Schenck	L. *roseus, a, um*, pink	*G. rósea*
Glomus		*Glómus*
G. aggregatum Schenck & Smith emend. Koske	L. *aggregatus, a, um*, grouped	*G. aggregátum*
G. albidum Walker & Rhodes	L. *albidus, a, um*, whitish	*G. álbidum*
G. ambisporum Smith & Schenck	L. *ambi*, both; Gr. *spora*, spore	G. *ambísporum*
G. arborense McGee	L. *arbor*, a tree; *ensis, is, e*	*G. arborénse*
G. australe (Berk.) Berch	L. *australis, is, e*, southern	*G. austrále*
G. boreale (Thaxter) Trappe & Gerdemann	L. *borealis, is, e*, northern	*G. boreále*
G. botryoides Rothwell & Victor	Gr. *botrys*, cluster of grapes; Gr. *oides*, like	*G. botryoídes*
G. caledonium (Nicol. & Gerd.) Trappe & Gerdemann	L. *caledonius, a, um*, pertaining to Scotland	*G. caledónium*
G. callosum Sieverding	L. *callosus, a, um*, horny skin, callose	*G. callósum*
G. canadense (Thaxter) Trappe & Gerdemann	Place Canada; *ensis, is, e*	*G. canadénse*
G. cerebriforme McGee	L. *cerebrum*, the brain; L. *forma*, form	*G. cerebrifórme*
G. citricolum Tang & Zang	*L. citrus*, citron tree; L. *colo*, to inhabit, to dwell	*G. citrícola*
G. claroideum Schenck & Smith	L. *clarus, a, um*, clear; Gr. *oides*, like	*G. claroídes*
G. clarum Nicolson & Schenck	*L. clarus, a, um*, clear, transparent	*G. clárum*
G. constrictum Trappe	L. *constrictus, a, um*, constricted	*G. constríctum*
G. convolutum Gerdemann & Trappe	L. *convolutus, a, um*, convolute	*G. convolútum*
G. delhiense Mukerji, Bhattacharjee & Tewari	Place Delhi; *ensis, is, e*	*G. delhiénse*
G. deserticola Trappe, Bloss & Menge	L. *desertum*, desert; L. *colo*, to dwell, to inhabit	*G. desertícola*
G. diaphanum Morton & Walker	L. *diaphanus, a, um*, colorless	*G. diáphanum*
G. dimorphicum Boyetchko & Tewari	Gr. *di*, two, twice; Gr. *morphe*, shape	*G. dimórphicum*
G. dominikii Blaszkowski	Honor Prof. Dominik; noun m.; *ii*, gen.	*G. dominíkii*
G. etunicatum Becker & Gerdemann	L. *e*, deprived of; L. *tunicatus, a, um*, clothed in a tunic	*G. etunicátum*
G. fasciculatum (Thaxter) Gerd. & Trappe emend. Walker & Koske	L. *fasciculatus, a, um*, clustered	*G. fasciculátum*
G. fecundisporum Schenck & Smith	L. *fecundus, a, um*, prolific; Gr. *spora*, spore	*G. fecundísporum*
G. flavisporum (M. Lange & Lund) Trappe & Gerdemann	L. *flavus, a, um*, gold-colored; Gr. *spora*, spore	*G. flavísporum*
G. formosanum Wu & Chen	Place Formosa; *anus, a, um*	*G. formosánum*

G. fragile (Berk. & Broome) Trappe & Gerdemann	L. *fragilis, is, e*, fragile	*G. frágile*
G. fuegianum (Spegazzini) Trappe & Gerdemann	Place Tierra del Fuego; *ianus, a, um*	*G. fuegiánum*
G. fulvum (Berk. & Broome) Trappe & Gerdemann	L. *fulvus, a, um*, yellowish brown	*G. fúlvum*
G. geosporum (Nicol. & Gerd.) Walker	Gr. *ge*, earth; Gr. *spora*, spore	*G. geósporum*
G. gerdemannii Rose, Daniels & Trappe	Honor Dr. Gerdemann; noun m.; *ii*, gen.	*G. gerdemánnii*
G. globiferum Koske & Walker	L. *globus*, sphere; L. *fero*, to bear	*G. globíferum*
G. glomerulatum Sieverding	L. *glomerulatus, a, um*, clumped	*G. glomerulátum*
G. halonatum Rose & Trappe	L. *halonatus, a, um*, haloed	*G. hálon*
G. heterosporum Smith & Schenck	Gr. *heteros*, different; Gr. *spora*, spore	*G. heterósporum*
G. hoi Berch & Trappe	Honor Dr. Ho; noun m.; *i*, gen.	*G. hói*
G. intraradices Schenck & Smith	L. *intra*, within; L. *radix*, root	*G. intrarádix*
G. invermaium Hall	Place Invermay; *anus, a, um*	*G. invermayánum*
G. lacteum Rose & Trappe	L. *lacteus, a, um*, milky, milk-white	*G. lácteum*
G. leptotichum Schenck & Smith	Gr. *leptos*, thin; Gr. *teichos*, wall	*G. leptotíchum*
G. macrocarpum Tul. & Tul.	Gr. *makros*, large; Gr. *karpos*, fruit	*G. macrocárpum*
G. maculosum Miller & Walker	L. *maculosus, a, um*, full of spots	*G. maculósum*
G. magnicaule Hall	L. *magnus, a, um*, large; L. *caulis*, stem	*G. magnicáule*
G. manihotis Howeler, Sieverding & Schenck	referring to the host, *Manihot; is*, gen.	*G. mánihot*
G. melanosporum Gerdemann & Trappe	Gr. *melanos*, black; Gr. *spora*, spore	*G. melanósporum*
G. microaggregatum Koske, Gemma & Olexia	Gr. *mikros*, small; L. *aggregatus, a, um*, grouped	*G. micraggregátum*
G. microcarpum Tul. & Tul.	Gr. *mikros*, small; Gr. *karpos*, fruit	*G. microcárpum*
G. monosporum Gerdemann & Trappe	Gr. *mono*, one; Gr. *spora*, spore	*G. monósporum*
G. mosseae (Nicol. & Gerd.) Gerdemann & Trappe	Honor Dr. Mosse; noun f.; *ae*, gen.	*G. mósseae*
G. multicaule Gerdemann & Bakshi	L. *multus, a, um*; many, L. *caulis*, stalk	*G. multicáule*
G. multisubstensum Mukerji, Bhattacharjee & Tewari	L. *multus, a, um*, many; L. *subtensus, a, um*, subtended	*G. multisubténsum*
G. occultum Walker	L. *occultus, a, um*, hidden	*G. occúltum*
G. pallidum Hall	L. *pallidus, a, um*, pale	*G. pállidum*
G. pansihalos Berch & Koske	L. *pandere* (*pansus*), to spread out; L. *halos*, halo	*G. pansihálos*
G. pubescens (Sacc. & Ellis) Trappe & Gerdemann	L. *pubescens, ens, ens*, pubescent	*G. pubéscens*
G. pulvinatum (P. Henn.) Trappe & Gerdemann	L. *pulvinatus, a, um*, cushion shaped	*G. pulvinátum*
G. pustulatum Koske, Friese, Walker & Dalpe	L. *pustulatus, a, um*, having pustules	*G. pustulátum*
G. radiatum (Thaxter) Trappe & Gerdemann	L. *radiatus, a, um*, radiate	*G. radiátum*

G. reticulatum Bhattacharjee & Mukerji	L. *reticulatus, a, um*, reticulate	*G. reticulátum*
G. scintillans Rose & Trappe	L. *scintillans, ans, ans*, sparkling	*G. scintíllans*
G. segmentatum Trappe, Spooner & Ivory	L. *segmentatus, a, um*, segmented	*G. segmentátum*
G. tenebrosum (Thaxter) Berch	L. *tenebrosus, a, um*, dark	*G. tenebrósum*
G. tenerum Tandy emend. McGee	L. *tener, era, erum*, soft-textured	*G. ténerum*
G. tenue (Greenhall) Hall	L. *tenuis, is, e*, thin	*G. ténue*
G. tortuosum Schenck & Smith	L. *tortuosus, a, um*, full of windings	*G. tortuósum*
G. tubaeforme Tandy	L. *tuba*, trumpet; L. *forma*, shape	*G. tubaefórme*
G. versiforme (Karsten) Berch	L. *versiformis, is, e (verso/forma)*, changing shape	*G. versifórme*
G. vesiculiferum (Thaxter) Gerdemann & Trappe	L. *vesicula*, small vesicle; L. *fero*, to bear	*G. vesiculíferum*
G. warcupii McGee	Honor Dr. Warcup; noun m.; *ii*, gen.	*G. warcúpii*
Sclerocystis		*Sclerocýstis*
S. clavispora Trappe	L. *clava*, club; Gr. *spora*, spore	*S. clavíspora*
S. coccogena (Pat.) v. Hohn.	Gr. *kokkos*, berry; Gr. *genes*, to be produced	*S. coccógena*
S. coremioides Berk. & Broome	Gr. *korema*, coremium; Gr. *oides*, like	*S. coremioídes*
S. dussii (Pat.) v. Hohn.	Honor Dr. Duss; noun m.; *ii*, gen.	*S. dússii*
S. indicus Bhattacharjee & Mukerji	Place India; *icus, a, um*	*S. índica*
S. microcarpus Iqbal & Bushra	Gr. *mikros*, small; Gr. *karpos*, fruit	*S. microcárpa*
S. pachycaulis Wu & Chen	Gr. *pachys*, thick; L. *caulis*, stem	*S. pachycáulis*
S. pakistanica Iqbal & Bushra	Place Pakistan; *icus, a, um*	*S. pakistánica*
S. rubiformis Gerdemann & Trappe	L. *rubus*, blackberry; L. *forma*, shape	*S. rubifórmis*
S. sinuosa Gerdemann & Bakshi	L. *sinuosus, a, um*, sinuous	*S. sinuósa*
Scutellospora		*Scutellíspora*
S. alborosea (Ferr. & Herr.) Walker & Sanders	L. *albus, a, um*; white; L. *roseus, a, um*, pink	*S. alborósea*
S. auriglobа (Hall) Walker & Sanders	L. *aurum*, gold; L. *globus*, sphere	*S. auriglobósa*
S. calospora (Nicol. & Gerd.) Walker & Sanders	Gr. *kalos*, beautiful; Gr. *spora*, spore	*S. calóspora*
S. coralloidea (Tarppe, Gerd. & Ho) Walker & Sanders	Gr. *corallion* or L. *corallum*, coral; Gr *oides*, like	*S. coralloídes*
S. dipapillosa (Walker & Koske) Walker & Sanders	Gr. *di*, two; L. *papillosus, a, um*, having papilla	*S. dipapillósa*
S. dipurpurescens Morton & Koske	Gr. *di*, two; L. *purpurascens, ens, ens*, becoming purple colored	*S. dipurpuráscens*

S. erythropa (Koske & Walker) Walker & Sanders	Gr. *erythros*, red; Gr. *trope*, turn, affinity for	*S. erýthropa*
S. fulgida Koske & Walker	L. *fulgidus, a, um*, shinning	*S. fúlgida*
S. gilmorei (Trappe & Gerd.) Walker & Sanders	Honor Dr. Gilmore; noun m.; *i*, gen.	*S. gilmórei*
S. gregaria (Schenck & Nicol.) Walker & Sanders	L. *gregarius, a, um*, associating together	*S. gregária*
S. heterogama (Nicol. & Gerd.) Walker & Sanders	Gr. *heteros*, different; Gr. *gamos*, gametes	*S. heterógama*
S. minuta (Ferr. & Herr.) Walker & Sanders	L. *minutus, a, um*, small	*S. minúta*
S. nigra (Redhead) Walker & Sanders	L. *niger, gra, grum*, black	*S. nígra*
S. pellucida (Nicol. & Schenck) Walker & Sanders	L. *pellucidus, a, um*, transparent	*S. pellúcida*
S. persica (Koske & Walker) Walker & Sanders	L. *persicus, a, um*, peach	*S. pérsica*
S. reticulata (Koske, Miller & Walker) Walker & Sanders	L. *reticulatus, a, um*, reticulate	*S. reticuláta*
S. savannicola (Herr. & Ferr.) Walker & Sanders	Latinization *savanna*, savannah; L. *colo*, to dwell, to inhabit	*S. savannícola*
S. tricalypta (Herr. & Ferr.) Walker & Sanders	Gr. *tri*, three; Gr. *kalypto*, cover	*S. tricalýpta*
S. verrucosa (Koske & Walker) Walker & Sanders	L. *verrucosus, a, um*, warty	*S. verrucósa*
S. weresubiae Koske & Walker	Honor Dr. Weresub; noun f.; *iae*, gen.	*S. weresúbiae*

specific epithet formed by L. *intra*, within, L. *radix*, root. The noun *radix*, *–icis* is third declension feminine and according to Stearn (1966), when used as an adjective, has the same nominative singular for all genders. The specific epithet of *G. intraradices*, as found in the species description, is in nominative plural of the noun and nominative plural masculine and feminine of the adjective. The suggested name for *G. intraradices* is *Glomus intraradix*, the epithet being either a noun in apposition or an adjective (Stafleu et al., 1983, Article 23.5).

According to Stafleu et al. (1983) in Article 32.5, names published with an incorrect Latin termination, but otherwise in accordance with this Code, are regarded as validly published. They are to be corrected without change of the author's name or date of publication. Trappe (1982) changed Latin endings of specific epithets in many *Glomus* species to agree grammatically with the neuter generic names. According to Morton (1988) such minor modifications are mildly irritating to researchers for a time, but they are necessary to preserve consistency in nomenclature.

Based on etymology typographic errors are found in the specific epithets of *Glomus multisubstensum*, that should be corrected to *G. multisubtensum*, and in *Scutellispora dipurpurescens*, corrected to *S. dipurpurascens*. The original spelling of a name or epithet is to be retained, except for the correction of typographic or orthographic errors, Article 73.1. Although Stafleu et al. (1983) recommend that names not be made by combining words of different languages, they established in example 2 from Article 62.1 that *Ardisia quinquegona* should not be changed to *A. pentagona*, even though the specific epithet *quinquegona* is a hybrid word of Latin and Greek. Similar words are found in the Endogonaceae, e.g. in the specific epithets of *Scutellispora dipapillosa*, Gr. *di*; L. *papillosa*, and *Sclerocystis pachycaulis*, Gr. *pachy*, L. *caulis*. Better names for these epithets would be *bipapillosa*, L. *bi*; L. *papillosa*, and *Sclerocystis pachycaula* or *pachycaulos* (Gledhill, 1985), Gr. *pachy*; Gr. *kaulos*, respectively. With *regard to the etymology of Glomus halonatum,* the word halonate, haloed was found in Snell & Dick (1971) and Hawksworth et al. (1983), but not in English dictionaries. Stearn (1966) gives the Latin adjective *halonatus*, *a*, *um*, haloed, from *halos,* halo, which is not found in Latin dictionaries. The word halo, L. *halos*, was found in Lewis & Short (1907) and in Cash (1965). Gledhill (1985) showed that the corresponding adjective in nominative singular for L. *halos* is *halos* (m.), *halos* (f.), *halon* (n.). In my opinion based on etymology, *Glomus halos* (the specific epithet as a noun in apposition, e.g., in *Glomus pansihalos*) or *Glomus halon* (the specific epithet as an adjective) are better and shorter names than *Glomus halonatum*.

Pronunciation of Scientific Names

According to Alcock (1876), it would be impossible to lay down absolute rules for the correct pronunciation of scientific names, and absurd to insist upon the accuracy of a certain pronunciation when another may be more customary. Latin is a "dead" language, and each nation pronounces these words according to the usage of its own language. The pronunciation of Verónica is much more common and is accepted by most, but according to Alcock (1876), based on its derivation, the correct accentuation is Veroníca and it is the pronunciation given by the older authorities. Lindsay (1923) points out that scientific names can be pronounced in any way preferred. There is no rule, and it is equally correct to say *Pittósporum* or *Pittospórum*. Although there are many exceptions, there are some rules that apply to the pronunciation of Latin words. According to Nybakken (1960) a Latin word has as many syllables as it has vowels and diphthongs (ae, au, ei, eu, oe). In Latin every vowel, including the final one, is pronounced, hence co–to–ne–as–ter and not cot–on–easter. The same rule applies to the Latinized Greek ending o–i–des (not oi–

des). The quantity of a syllable is either long or short. A syllable is long if it contains a long vowel or a diphthong or if it has a short vowel followed by two consonants or by x or z. The last syllable is never accented. If the next to the last syllable is long it receives the accent; otherwise, the accent falls on the preceding syllable, the antepenult. Also, Nybakken (1960) provides the vowels and diphthongs in Latin with their respective pronunciations in English: a (as in arch and father), e (met, prey), i (pit, machine), o (obey, hole), u (full, rule), ae (aisle), au (out) ei, (freight), eu (feud) and oe (boil). The Latin consonants have the same sounds as they have in English except that: c is pronounced like cap; g like gas, v like w in window and s like son.

In a survey on pronunciation of the genera in the Endogonaceae conducted at the University of Florida, Gainesville, involving 30 individuals working in biological sciences, with many working on VA mycorrhizal fungi, the following results were obtained: *Glómus* (100%), *Sclerocýstis* (100%), *Endógone* (80%), *Endogóne* (20%), *Acaulóspora* (40%), *Acaulospóra* (60%), *Gigaspóra* (60%), *Gigáspora* (40%), *Entrophospóra* (66.6%), *Entrophóspora* (33.3%) and *Scutellóspora* (80%), *Scutellospóra* (20%). *Pittosporum* is a compound name, Gr. *pitta,* pitch, and Gr. *spora,* seed, *Pitt-o-sporum*, formed in the same way as most genera in the Endogonaceae, and having the last Greek word–*spora*. Bayley (1963), Lindsay (1923), and Nybakken (1960) applying the rules mentioned previously for pronunciation would prefer *Pittósporum*. Nybakken's recommendation for accentuation of the names applied to the genera of the Endogonaceae that have two consonants following one vowel would be *Sclerocýstis*, *Gigáspora*, *Scutellóspora*, *Acaulóspora* and *Entrophóspora*. Stearn (1966) indicates that for –*gone*, reproductive organs, used in Greek compounds, the correct pronunciation is *Endógone*. In order to have a more uniform pronunciation, based on these observations, for the genera in the Endogonaceae the following accentuation is suggested: *Glómus, Sclerocýstis, Endógone, Acaulóspora, Entrophóspora, Gigáspora* and *Scutellóspora*.

The author would be pleased if this paper contributed to a more uniform nomenclature for species in the Endogonaceae. Authors should give more attention to etymology and to the rules of the International Code of Botanical Nomenclature, when naming new species in this important family of fungi. To accomplish this the suggested references for reading and consulting are Stafleu et al. (1983), Stearn (1966), Gledhill (1985), Ayers (1977), Nybakken (1960), Brown (1956), and Latin and Greek dictionaries or glossaries.

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MYCOTAXON

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CONTRIBUTION TO THE LICHEN FLORA OF BRAZIL.XXIII. LICHENS FROM SAO PAULO CITY.

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SUMMARY: Seventeen lichens gathered in two forested localities within Sao Paulo City, Brazil, are listed.

During November 1968 the author was able to collect lichens in two forested areas located in Sao Paulo City, Brazil.
One of them was the park surrounding the well known "Instituto Butantan" (IB). The other collection site was the "Horto Florestal" (HF) composed of remnants of tropical forest in the zone named Cantareira, 15 km far from the central part of Sao Paulo City.
Both localities are situated inside the urbanized area of Sao Paulo City and surrounded by a high density of population.
I do not know the present status of both places,but the increased pollution occurring in the last 20 years in Sao Paulo led us to suppose possible damage to the lichen flora.
Notwithstanding the small number of collections, the occurrence of some taxa rarely reported in the literature dealing with the studied area encouraged the author to publish the present list. The numbers between parentheses belong to my numbering system and are preserved in my private herbarium.

Bulbothrix tabacina (Mont. & v.d. Bosch) Hale
IB.: on trunk of a tree (Leguminosae) (4920),det. M. Hale
Candelaria concolor (Dicks.) Arn.
IB.: on trunk of *Melia azedarach* (4917).
Catinaria versicolor (Fée) Sipman
HF.: on trunk of a tree (4895).
Chiodecton sanguineum (Sw.) Vain.
IB.: on trunk of trees, locally common (4923).
HF.: on trunk of a tree (4894, 4899).
Cladonia subradiata (Vain.) Sandst.
IB.: on bark of a tree (Myrtaceae) (4924), det. T. Ahti
HF.: on soil, inner part of the forest (4902), det. T. Ahti
Dirinaria picta (Sw.) Clem. & Shear
IB.: on trunk of *Melia azedarach* (4918)
Glyphis cicatricosa (Ach.) Vain. f. *confluens* (Zenk.)Zahlbr.
HF.: on trunks of shrubs (4913 pro parte).
Parmelina pilosa (Nyl.) Hale
HF.: on trunk of a tree (4903).

Parmotrema sancti-angelii (Lynge) Hale
HF.: on trunk of a tree (4898).
Parmotrema tinctorum (Nyl.) Hale
IB.: on trunk of a tree (Leguminosae) (4921).
HF.: on trunk of trees (4893, 4897, 4906).
Phaeographina caesiopruinosa (Fée) Müll. Arg.
HF.: on trunk of Melia azedarach (4908), on trunk of shrubs (4913 pro parte, 4914, 4915).
Phlyctella brasiliensis (Nyl.) Nyl.
HF.: on trunk of a tree (4909).
Pseudoparmelia caroliniana (Nyl.) Hale
IB.: on trunk of a tree (Leguminosae) (4925), det.M. Hale
Pseudoparmelia texana (Tuck.) Hale
IB.: on trunk of a tree (Leguminosae) (4919, 4926), det. M.Hale
Pseudopyrenula diluta (Fée) Müll. Arg.
HF.: on trunk of a shrub (4911), det. R. Harris
Punctelia rudecta (Ach.) Krog
HF.: on trunk of a tree (4896), conf. M. Hale
Tylophoron protrudens Nyl.
HF.: on bark of a tree, N slope of a small hill (4904), det. L. Tibell.

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A NEW SPECIES AND FIRST RECORD OF GYMNOPAXILLUS (HYMENOGASTRALES) FROM ARGENTINA

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SUMMARY

Gymnopaxillus crubensis is described from North-Western Patagonia. The new species grows sub-hypogeously,on soil, under *Nothofagus pumilio* and *N.dombeyi*. *Gymnopaxillus morchellaeformis* Horak is reported for the first time from Argentina. Up to now the genus *Gymnopaxillus* Horak was monospecific and previously recorded only from Tierra del Fuego, Chile.

DESCRIPTION

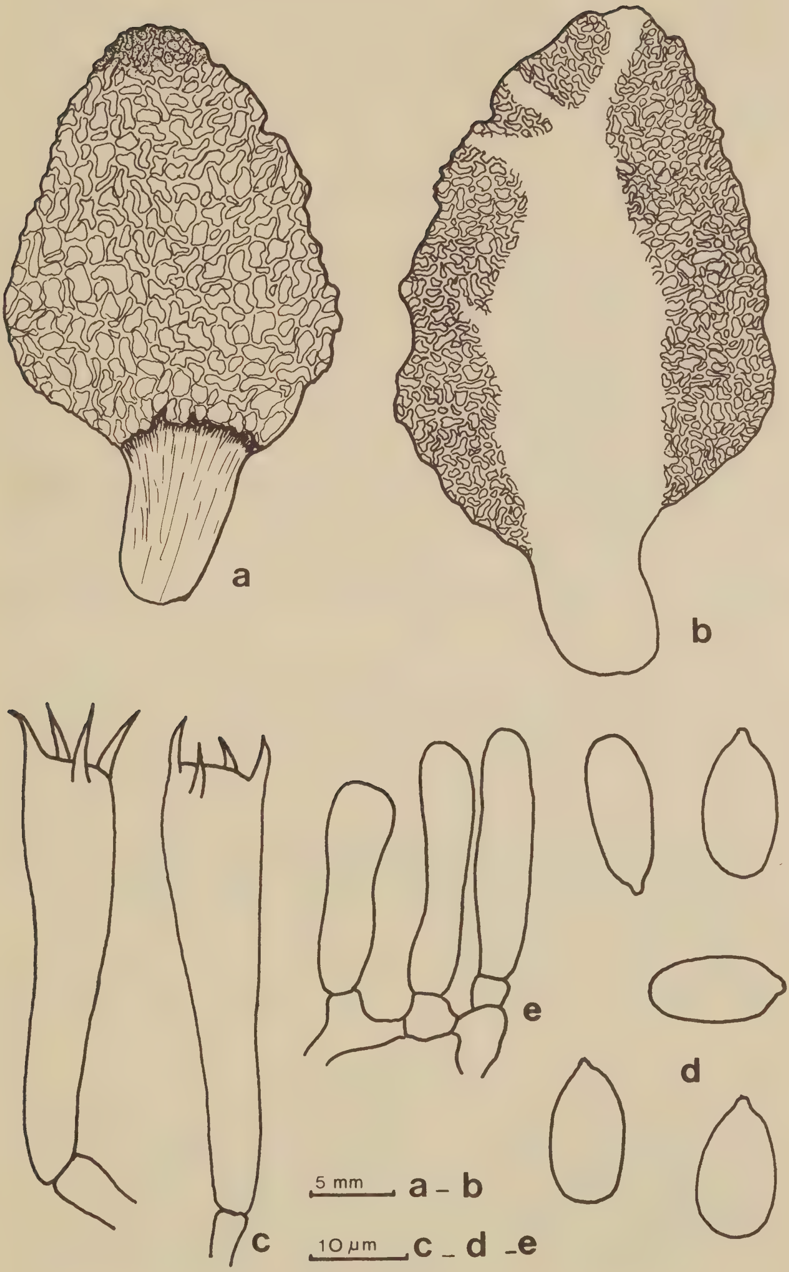
Gymnopaxillus crubensis Calvelo & Lorenzo. Fig.1

Carposomatis subhypogaeis, habitu morchelliforme. Pileo 12-22 mm lato, 20-26 mm alto, ellipsoideo vel subgloboso, ferrugineobrunneo, peridio nullo. Gleba exposita et denudata, morchelaeforme, loculis 0.5-1.5 mm, sicca. Stipite 3-8 mm lato, 8-15 mm alto, cylindraceo vel ad basin versus attenuato,albidus, sicco. Columella ramosa, plena, deinde vetustate subcava. Odore et sapore gratus vel fortis aromaticus, Solanum tuberosum assus simile. Sporis (8-) 10-14 (-15) x (4-) 5-7 µm, symmetricis, ovoideis vel subfusoideis, auriantio luteus, numquam episporio perforato, poro germinativo nullo. Basidia 33-42 x 6-9 µm, tetrasterigmata. Cystidiis nullis. Fibulae absentes. Ad terram in Nothofagetis (Nothofagus pumilio). Holotypus in Herbario BAFC 31767 conservatum est.

Carpophore fleshy, pileate, caespitose and gregarious. Pileus 12-22 mm wide, 20-26 mm height, broadly ellipsoidal to subglobose; brownish-ferrugineous; hymenium morchellaeform, irregularly wrinkled in small chambers 0.5-1.5 mm, not following a regular pattern of distribution; with rest of peridium present only at the apex of the pileus. Stalk 3-8 mm wide, 8-15 mm height, cylindrical, slightly tapering to the base, white, dry. Columella irregularly branched, up to the apex of the pileus, solid, partially hollow after desiccation. Smell and flavour delicious, resembling roasted potatoes. Chemical reactions of context: KOH negative, ClH negative, KOH-ClH negative. Spores (8-) 10-14 (-15) x (4-) 5-7 µm, bi-radial symmetric, ovoid to subfusiform, appendix apical, smooth, golden-yellowish, without germinative pore. Spores in mass ferrugineous. Basidia 4-spored, cylindrical, 33-42 x 6-9 µm, sterigmata 4-6 µm long. Basidiole cylindrical, unbranched, 21-30 x 4-5 µm. Without cystidia. Tramal hyphae cylindrical, 2-6 µm diam.,smooth, not jellified, without clamp connections.

Holotype: Argentina, Prov. de Río Negro. Parque Nacional Nahuel Huapi, headwaters of Río Ñireco, 1560 m above sea level. On soil, Nothofagus pumilio forest, S.Calvelo, 26-II-1989. BAFC 31767. Isotype: BCRU 00140

Fig.1 Gymnopaxillus crubensis
a- Carpophore
b- Carpophore, longitudinal section.
c- Basidia
d- Basidiospores
e- Basidioles


a
b
c
d
e
5 mm
a – b
10 µm
c – d – e

Additional specimens examined: Argentina, Prov. de Río Negro, Parque Nacional Nahuel Huapi, Puerto Alegre, 820 m above sea level. On soil, *Nothofagus dombeyi* forest, L. Lorenzo, 15-III-1985. BCRU 00141.

REMARKS

The genus appears to be endemic of southern South-American *Nothofagus* forests.The species is strongly water dependent, since the collections were made in places with very high precipitations levels, headwaters of Río Ñireco: 1900 mm/year, and Puerto Alegre: 3000 mm/ year. Furthermore, on soil with high content of water, one a few meters away from a bog and the other from a lake.

Gymnopaxillus crubensis grows subhypogeously and inconspicuously on humus under fallen leaves of *Nothofagus* sp.

The new species is close to *G.morchellaeformis* Horak with which our specimens were compared; the results are shown on Table 1.

The name of the new species refers to CRUB, Centro Regional Universitario Bariloche, were the authors develop their research work.

NEW RECORD

Gymnopaxillus morchellaeformis Horak,described from Tierra del Fuego, Chile, is reported for the first time from Argentina, Lago Roca, Prov. de Santa Cruz.

Specimens examined: Argentina, Prov. de Santa Cruz, Lago Roca, Leg. ?, III?- 1986. BAFC 30668.

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Table 1. Differential features between *Gymnopaxillus* species.

	Gymnopaxillus crubensis (BAFC 31767)	*Gymnopaxillus morchellaeformis* (LPS 38227)
Columella and stalk	white, not concolourous with the pileus	concolorous with the pileus
Hymenium chambers	0.5-1.5 mm, without a regular pattern of distribution	6 mm, distributed along longitudinal ribs
Smell-flavour	delicious	disagreeable
Context chemical reactions (KOH-ClH)	negative	positive
Spores	10-14 µm golden-yellowish appendix apical bi-radially symmetric ovoid to subfusiform	12-15 µm brownish-yellow appendix lateral asymmetric fusiform to ellipsoid
Basidia	33-42 x 6-9 µm	48-65 x 8-10 µm
Sterigmata	4-6 µm	3 µm
Basidioles	21-30 x 4-5 µm, unbranched	20-45 x 4-7 µm, branched

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A TAXONOMIC REVISION OF THE GENUS CHEILYMENIA - 1.

SPECIES CLOSE TO CHEILYMENIA RUBRA.

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ABSTRACT

Type material of Cheilymenia rubra (Cooke ex Phill.) Boud. and Cheilymenia humarioides (Rehm) Gamundí has been examined. Two new taxa are described: Cheilymenia pseudohumarioides Dissing,J.Moravec et Sivertsen based on collections from Greenland, and Cheilymenia liskae J.Moravec,Fellner et Landa spec. nov. based on a collection from Svalbard, West Spitsbergen. One new combination, Scutellinia alleghenensis (Denison) comb.nov., based on Cheilymenia alleghenensis Denison (1964) is proposed. Descriptions, line drawings and SEM photomicrographs of ascospore ornamentation accompany the paper.

INTRODUCTION

Taxonomic revision of the genera Coprobia Boud. em. J.Mor. and Cheilymenia Boud. has revealed that these are large genera with many species. It is intended that the results of the examination of almost all relevant type material will be published in several parts, culminating in a monograph of these genera. In the present paper, the results of an examination of material of Cheilymenia rubra (Cooke ex Phill.) Boud. and Cheilymenia humarioides (Rehm) Gamundi are presented, and two new taxa are described.

MATERIAL AND METHODS

Relevant type material from the herbaria of the Royal Botanic Gardens, Kew (K), Instituto de Botánica "Spegazzini", La Plata (LPS), The New York Botanical Gardens, New York (NY) and Oregon State University, Corvallis (OSU) were examined. Dried specimens were revived in 4 % NH_4 OH. Sections were stained in Cotton Blue in lactic acid (CB) and fuchsin acid. In the case of C. pseudohumarioides, ultramicrotome sections were prepared and sent to me by Dr. H. Dissing, Kobenhagen. Ascospores were observed and measured under an oil immersion objective at a magnification x 1600. The perisporial ornamentation of ascospores was studied on sections stained with CB Geigy S. 123, which stains promptly without heating the slides. This is important as heating may easily destroy the perisporium . A scanning electron microscope TESLA BS 300 was used and the photomicrographs (SEM) were prepared from dried specimens in the usual way.

TAXONOMIC RESULTS

Cheilymenia rubra (Cooke ex Phill.) Boud.

Peziza theleboloides Alb.et Schw. var. rubra Cooke, Fungi Britt. ser. 1 N° 572, 1872; Grevillea III, fig 119, 1874.
Peziza (Sarcoscypha) rubra Cooke, Mycographia 83,1876 (nomen abortivum).
Lachnea rubra Cooke ex Phillips, British Discom. 225, 1887.
Scutellinia rubra (Cooke ex Phill.) Kuntze, Rev. Gen. Plant. 2:869, 1891.
Cheilymenia rubra (Cooke ex Phill.) Boudier, Hist. class. Discom. Eur. 63, 1907.

Apothecia 2-5 mm diam., sessile, scattered to crowded, subglobose and closed when young, becoming shallow cupulate to discoid, fleshy; hymenium orange-red (the dried apothecia are dark reddish-brown), externally concolorous or paler, covered with short, brownish hairs of a very irregular size; these are densely aggregated at the margin of the apothecia where long hairs are mixed with small hairs or pyriform cells with thickened, brownish walls, giving a brownish colour to the marginal zone. Rooting marginal hairs 80-320 x 12-28 µm, pale brown to reddish-brown, rigid, thick-walled (walls 1.5-4 µm thick), usually pointed above, irregularly more or less curved, with a simple attenuated base or, rarely, with a shortly bifurcate base, arising among the excipular cells. Hairs of the lower surface of the excipulum are smaller, 40-160 x 10-25 µm, with thinner walls and occasionally with hyaline tips. Ectal excipulum of textura globulosa-angularis, consisting of 4-5 rows of large cells, which become smaller and angular towards the margin of apothecia, and very large and globose near the base, (15-)45-80 (-100) µm diam. Medulla composed of compact, interwoven, often inflated, hyaline hyphae, which are 7-12 µm thick, forming a textura intricata. Hypothecium poorly differentiated,consisting of smaller hyphae. Asci 135-170 x 14-21 µm, cylindrical with rounded tips and attenuated below towards a simple or inconspicuously bifurcate base, 8-spored. Ascospores uniseriate, ellipsoid, (15-)16.5-21(-22.5) x (8-) 9-11(-12) µm, mostly 19 x 10.5 µm, subhyaline, without guttules, with a yellow refractive colour when stained with CB and with a loosening perisporium covered by fine, low, irregular cyanophilic warts and crests 0.1-1.0 µm diam. and up to 0.3 µm high. Paraphyses filiform, 3-4 µm thick, with apex slightly enlarged to 4-6·(-7) µm diam., clustered together.
Habitat: On spent decaying hops and vegetable debris, straw mixed with dung and soil.
Material examined: England, Batheaston, on spent hops, April 1872 leg. E.C. Broome, labelled "P. theleboloides red form" (K ex Cooke, holotype); England, Batheaston, s.date (NY ex herbarium of G. Massee, isotype); Ed.1, N° 572 and N° 186 of Fungi Brittanici Exsiccati, labelled Peziza (Sarcoscypha) rubra (K); Switzerland, Zürich, "on the ground", April 1888

leg G. Winter, Fungi Helvetici Suppl. 78, labelled Lachnea rubra (K).
This taxon was first described as a variety of Peziza theleboloides and later described at specific rank by Cooke (1876) under the invalid name Peziza (Sarcoscypha) rubra Cooke (a later homonym of Peziza rubra Peck 1872).
It was redescribed by Phillips (1887) under the new name Lachnea rubra Cooke. As Phillips used Cooke's epithet and attributed it to the author, the correct name for this species, following the combination in Cheilymenia by Boudier (1907), is Cheilymenia rubra (Cooke ex Phill.) Boud.
All packets of the type material contain the same species. The holotype must be the specimen collected by C.E. Broome and labelled "P. theleboloides red form", which includes about eight apothecia growing on spent hops. Material, which is apparently a part of the same collection is deposited in NY herbarium and must be considered to be isotype, though Denison (1964) referred to it as "holotype". The two other collections deposited in K as well as Winter's collection (NY) represent the same species. However, the substrate of Winter's collection is not just soil ("on the ground" as annotated by Winter) but in fact consists of soil mixed with straw and chaff (probably from horse dung) and the apothecia are growing on the vegetable debris.
It should be noted that another specimen deposited in NY labelled as "Sarcoscypha rubra Cooke (Sur les feuilles pourrissantes dans les bois, au voisinage du type, Shrewsbury (Angleterre), Mars 1882 leg. W. Phillips) and with a diagnose identical to that of Cooke,is, in my opinion, Coprobia theleboloides (Alb.et Schw.) J.Mor. I have found only apothecia with superficial, pale hairs and immature asci without developed ascospores. According to Cooke (1876), C. theleboloides often grows together with C. rubra on the same substrate (spent hops), and this may explain the error.
The most conspicuous features of C. rubra are the short but rigid thick-walled brownish hairs, which have a simple or shortly bifurcate base, and the irregular arrangement of the hairs, which are densely mixed with copious, very short hairs or even pyriform or irregularly-shaped cells with brownish thickened walls, giving a brownish colour to the marginal zone. The size and shape of the hairs, their arrangement, and also the larger ascospores clearly distinguish C. rubra from Cheilymenia coprinaria (Cooke) Boud. as has already been stated by Denison (1964). The type of C. coprinaria (K) has also been examined (J.Moravec 1989).

Cheilymenia humarioides (Rehm) Gamundí

Lachnea humarioides Rehm, Bih. Kon. Sv. Vet. Ak. Handl 25; Afd. III, N° 6:11, 1899.
Cheilymenia humarioides (Rehm) Gamundí, Bull. Soc. Argent. 14 (3):168, 1972.

Apothecia 1-3 mm diam., sessile, gregarious, at first subglobose, becoming cupulate to discoid with an undulate margin, fleshy, hymenium bright orange-red when fresh, becoming orange-red when dry, with a pale yellowish margin, external surface paler, covered with scattered curved hairs; Hairs brown, becoming hyaline in their upper part (as seen

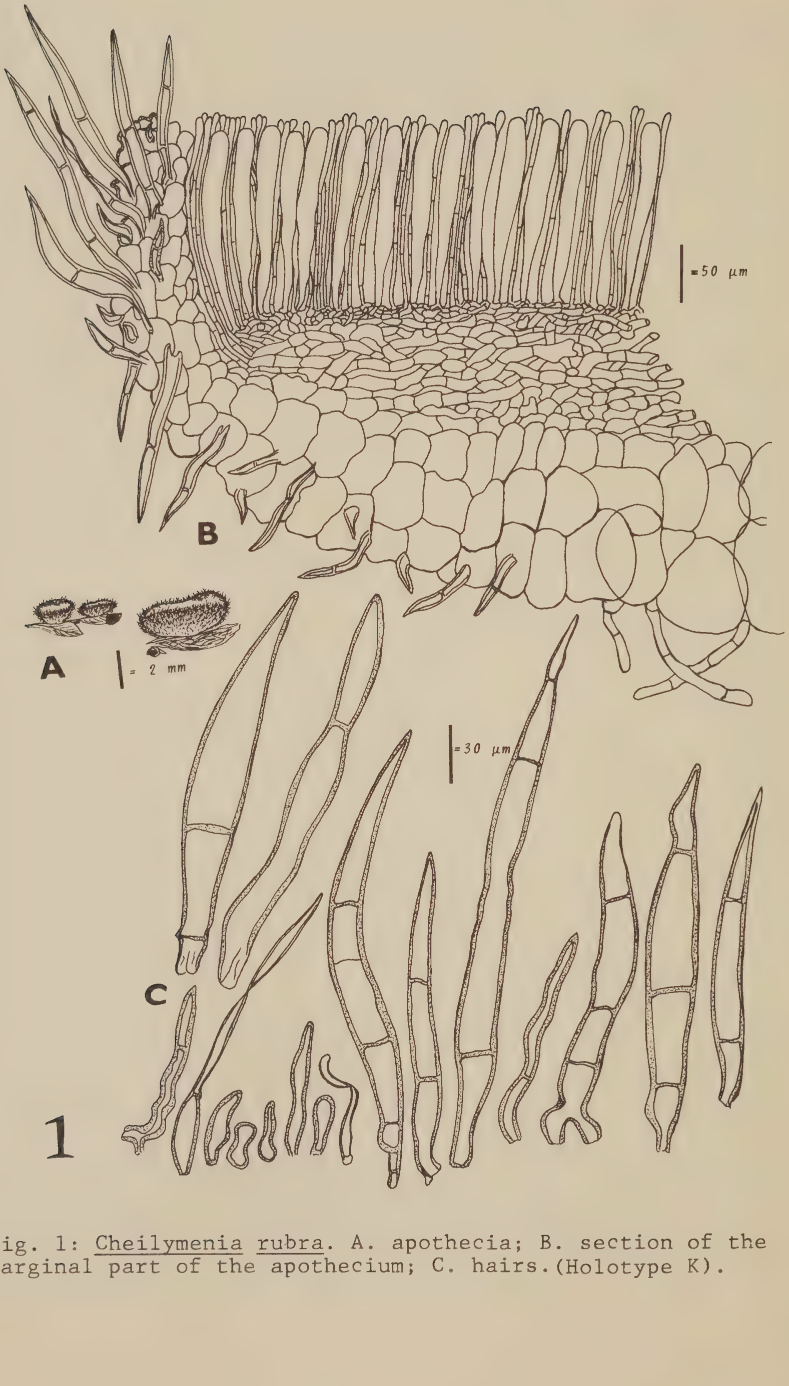
=50 µm
B
A
= 2 mm
=30 µm
C
1

Fig. 1: Cheilymenia rubra. A. apothecia; B. section of the marginal part of the apothecium; C. hairs. (Holotype K).

with the naked eye). Rooting marginal hairs 90-300(-400) x 11-25 µm, rigid, yellow-brown to brownish, apically colourless, obtuse to pointed at the apex, sparsely septate or rarely lacking septa, thick-walled,(the walls 1-2 µm thick) with a bifurcate or simply attenuated base, arising deeply within the ectal excipulum. Hairs towards the base of the excipulum yellowish or subhyaline, septate, with an obtuse apex, 90-180 x 8-15 µm. Ectal excipulum a textura globulosa-angularis composed of pale yellowish cells, 20-75 µm diam., which are more angular and smaller towards the margin of apothecia and become subglobose and angular towards the base. Medullary excipulum clearly differentiated, comprising a textura intricata composed of interwoven, often inflated, mostly horizontally arranged 4-7 µm thick hyphae. Hypothecium poorly developed, composed of smaller hyphae and cells. Asci 150-240 x 16-26 µm, cylindrical with subtruncated tips, shortly attenuated towards a simple or shortly bifurcate base, inamyloid, 8-spored. Ascospores uniseriate, ellipsoid, (19.2-)21-26(-28.5) x 12-14.5(-15.7) µm, mostly 24 x 13.8 µm, without guttules, subhyaline, with a dark yellow refractive colour when stained with CB. The ascospore wall consists of three layers, the perisporium bearing conspicuous,cyanophilic rounded or irregular warts 0.3-1.5(-2.5) µm diam. and 0.2-1 (-1.5)µm high (measured under oil immersion + CB). Paraphyses filiform, simple, septate, 3-4 µm thick, the upper cells somewhat enlarged (4-9 µm) containing yellowish to orange pigment.
Habitat: coprophilous, collected on cow-dung and horse excrements in Argentina and Chile.
Material examined: Argentina, Tierra del Fuego,Depto.Ushuaia, alrededores de Ushuaia, "malin" al NE del pueblo, 20.I.1964 leg. I.J.Gamundí (Neotype LPS 33427a).
Cheilymenia humarioides is a distinct species which differs from C. rubra in having larger ascospores with a three layered wall. This unusual feature has already been noted by Gamundi (1972,1975). The ornamentation of the perisporium (the external delicate easily loosening coat) consists of much larger and higher warts than that in C. rubra (compare also SEM photomicrographs). Moreover, the apothecia of C. humarioides are smaller and not so densely covered with hairs, the hairs being usually colourless in their upper parts and with thinner walls. For a detailed illustration of apothecia, their anatomy and other microfeatures see Gamundí (1972,1975). The ascospore perisporium was described and illustrated as smooth by Gamundi, perhaps because the slides with sections stained in lactophenol were heated, and the perisporium consequently destroyed.
C . humarioides is known from 7 other collections from Argentina (Tierra del Fuego) and 2 collections from Chile examined by Gamundí (1972,1975). Holotype material does not exist and the neotype selected by Gamundi (1972) is from the same area as the original collection.

Cheilymenia pseudohumarioides Dissing, J.Moravec et Sivertsen **spec.nov.:**

Apothecia 2-3 mm diam., gregaria, breviter turbinata, usque discoidea, margine tenui, albido, disco aurantiaco usque

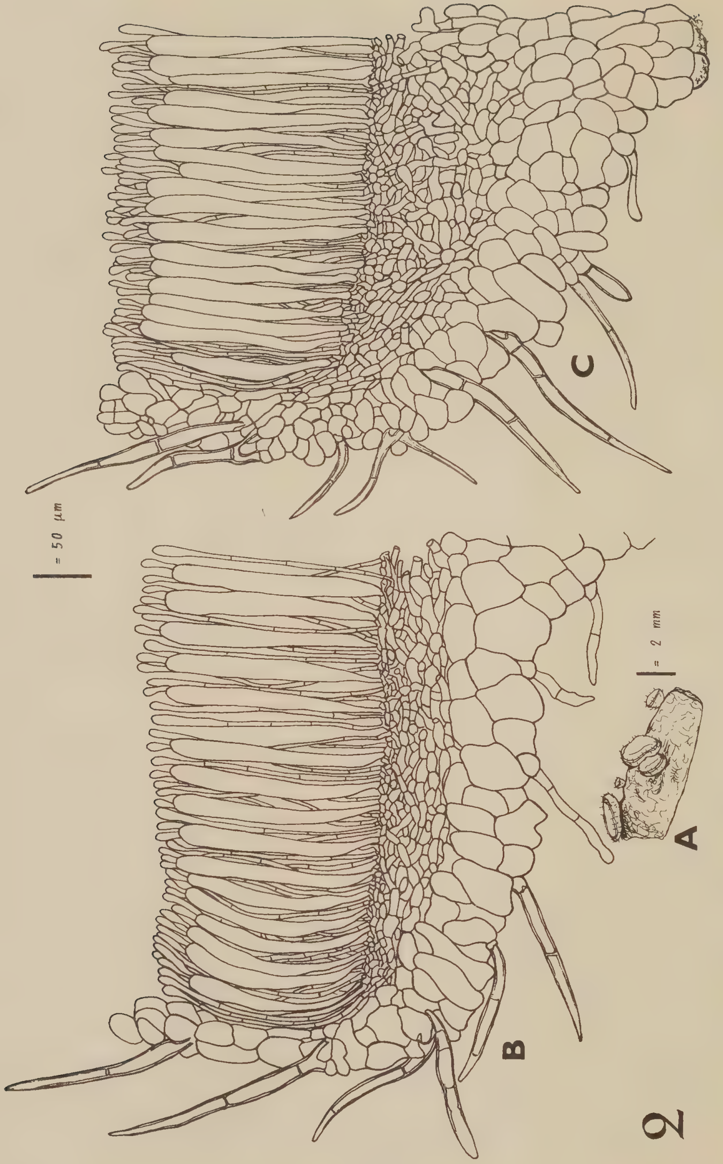

Fig. 2: Cheilymenia pseudohumarioides. A. apothecia; B. section of apothecium of the holotype (C); C. section of apothecium of the paratype Gr.8387 (C).

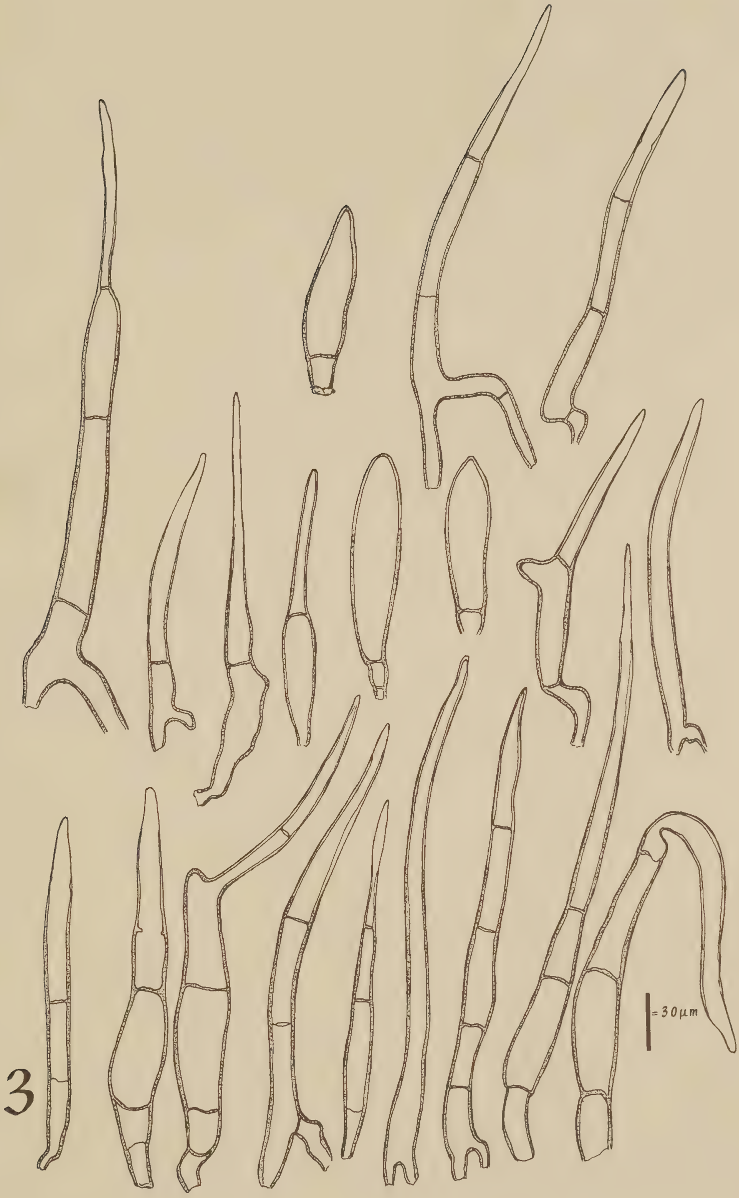

Fig. 3: Cheilymenia pseudohumarioides. Hairs. (Holotype C).

laete aurantiaco-rubro, extus pallide aurantiaca, pilis pallidis disperse obsita. Pili 80-300 x 8-27 µm, luteofusci, parte superiori ecolorati, membranis 1-2 µm crassis, sparse septati, curvati, apice acuti vel obtusi, infra attenuati, basi simplices vel interdum bifurcati. Excipulum externum textura angulari usque globuloso-angulari. Excipulum internum (medulla)e textura intricata constat. Asci cylindracei, 187-250 x 16-22 µm, apice obtusi, infra angustati, basi nonnumquam breviter bifurcati, octospori. Ascosporae monostichae, late ellipsoideae, (18.2-)19-22.8 (-24) x (10.8-)12-13.8(-15) µm, creberime 20 x 12.5 µm, eguttulatae, perisporio verrucis cyanophilis, 0.1-0.3 µm diam., 0.1 µm altis. Paraphyses filiformes, (1.3-)2.5-4 µm crassae, apice 5-10 µm dilatatae, granulis vel fibrillis aurantiaco-coloratis impletae.
Habitat: fimicola.
Holotypus: Greenland, prope Nyhavn, Metsersvig, in fimo Brantae berniclae, 5.VIII. 1983 leg. H. Dissing. (Holotypus in herbario C, isotypus BRA, Paratypus PRM.

Apothecia 2-3 mm diam., low turbinate to discoid with a pale margin, hymenium light orange to bright orange-red, dried apothecia yellow ochraceous to ochraceous, outer surface concolorous, covered with pale hairs, which are sparsely scattered. Rooting marginal hairs 80-300 x 8-27 µm, straight or often curved or wavy, yellow-brown, apically colourless, sparsely septate, usually bifurcate bellow or with a simple attenuated base; excipular hairs near the base of the apothecia shorter, with thinner walls (up to 1.5 µm thick). Excipulum clearly differentiated: Ectal excipulum a textura angularis of two rows of cells, which become subglobose or vertically elongated towards the base of the apothecia, smaller and angular towards the margin, (15-)25-45 (-75) µm diam.,with orange pigment. Medullary excipulum a textura intricata composed of interwoven, inflated hyphae occasionally mixed with globose to irregularly angular elements, the hyphae 5-12 µm thick, septate, hyaline. Hypothecium not clearly differentiated, composed of smaller hyphae and cells. Asci 187-250 x 16-22 µm, cylindric with rounded or broad pleurorhynchous base, eight-spored, inamyloid. Ascospores uniseriate, globose-ellipsoid to broadly ellipsoid, (18.2-)19-22.8(-24) x (10.8-)12-13.8(-15) µm, hyaline, without guttules, with a refractive yellow colour when stained with CB, the loosening perisporium covered with inconspicuous fine cyanophilic warts 0.1-0.3 µm diam. and 0.1 µm high. Paraphyses filiform, straight, sometimes branched, (1.3-)2.5-4 µm thick, enlarged to 5-10 µm thick at the apex, with orange granular to fibrous content. In Melzer's reagent the carotenoids in the paraphyses and excipulum stain at first bluish for a very short while, than become reddish-brown to violet and finally dark greenish.
Habitat: On dung of Barnacle goose and summer dung of musk-ox.
Holotype: East Greenland, 72°15′N,24°W near Nyhavn, Metsersvig, on old dung of Barnacle goose, 5.VIII.1983 leg. Henri Dissing (Gr.83.96-holotype C, isotype BRA).
Paratypes: East Greenland, Along Gåsesøen, near the aeroport in Mestersvig, Kong Oscar Fjord, on dung of Barnacle goose, 9. VIII.1982 leg. H.Dissing et S.Sivertsen (Gr.82.134,C,BRA);

East Greenland, Near Nyhavn, Metsersvig, on summer dung of musk-ox, 2.VIII. 1983 leg. H.Dissing (Gr.8387, C, BRA).

This new species has several features which are virtually identical to those exhibited by C. humarioides, notably the size and shape of the hairs, which are colourless in their upper part, the broadly ellipsoid ascospores which are of a similar size, the shape and size of asci, and excipular construction. However, the ascospore wall in C. humarioides consists clearly of three layers and the perisporium is covered by much larger and higher warts,whilst the ascospore wall in C. pseudohumarioides consists of only two layers and the perisporium has a finer ornamentation of much smaller and lower warts giving it a punctate appearance. In both species the perisporium is easily separable, as in other species of the genus. C. rubra clearly differs from the new species in having larger apothecia with much more densely arranged hairs, especially near the margin, giving a dark brown colour to the marginal zone. In contrast, apothecia of C. pseudohumarioides are only sparsely covered with paler hairs, which are scarcely visible to the naked eye.
In addition, marginal hairs in C. rubra are entirely brownish, without a hyaline apex; only hairs near the base of apothecia occasionally have a colourless apex.
In C. pseudohumarioides, C. humarioides and C. liskae, the marginal hairs often possess a hyaline apex, which extends approximately one third of the hair length. Moreover, the ascospores of C. rubra are narrower than the ascospores of these three species.
All the apothecia of examined material of C. pseudohumarioides are yellow-ochraceous when dried, with only scattered pale hairs as seen on the revived apothecia. The above description of fresh apothecia is based on observations made in the field laboratory in Mestersvig by Dr. H.Dissing, accompanied with colour slides, and sent to me together with the material. The collection from musk-ox excrement has more reddish apothecia (when fresh,according to the colour slide) and slight differences in excipular construction (see fig.2), but, based on its other features, I consider it identical with the holotype.

Cheilymenia liskae J.Moravec, Fellner et Landa spec.nov.

Apothecia 1-5 mm diam., primum subglobosa dein subpatellaria usque discoidea, disco aurantiaco, extus concolor, pilis brevibus, saepe curvatis, pallidis, solum basi brunneo-coloratis obsita. Pili 90-240 x 10-30 µm, rigidi, recti vel curvati, luteo-fusci, parte superiori ecolorati, apice acuti, sparse septati (septis 1-4 instructis), membranis 1.5-3 µm crassis, ad bases radicantes, saepe basi bifurcati vel trifurcati (rarior quadrifurcati) sed etiam simplices, attenuati; praeterea pili breves, clavati, luteo-fusci adsunt.
Excipulum externum textura globuloso-angulari. Excipulum internum (medulla) e textura intricata constat. Asci 150-180 x (18-)19.5-25(-27) µm, crasse cylindracei, sursum saepe attenuati, apice obtusi vel truncati, deorsum breviter angustati, basi simplici, octospori. Ascosporae mono - vel distichae, ellipsoideae, (18-)19.5-21(-22.5) x 10.5-12(-13.6) µm, subhyalinae, eguttulatae, perisporio separabili, verrucis

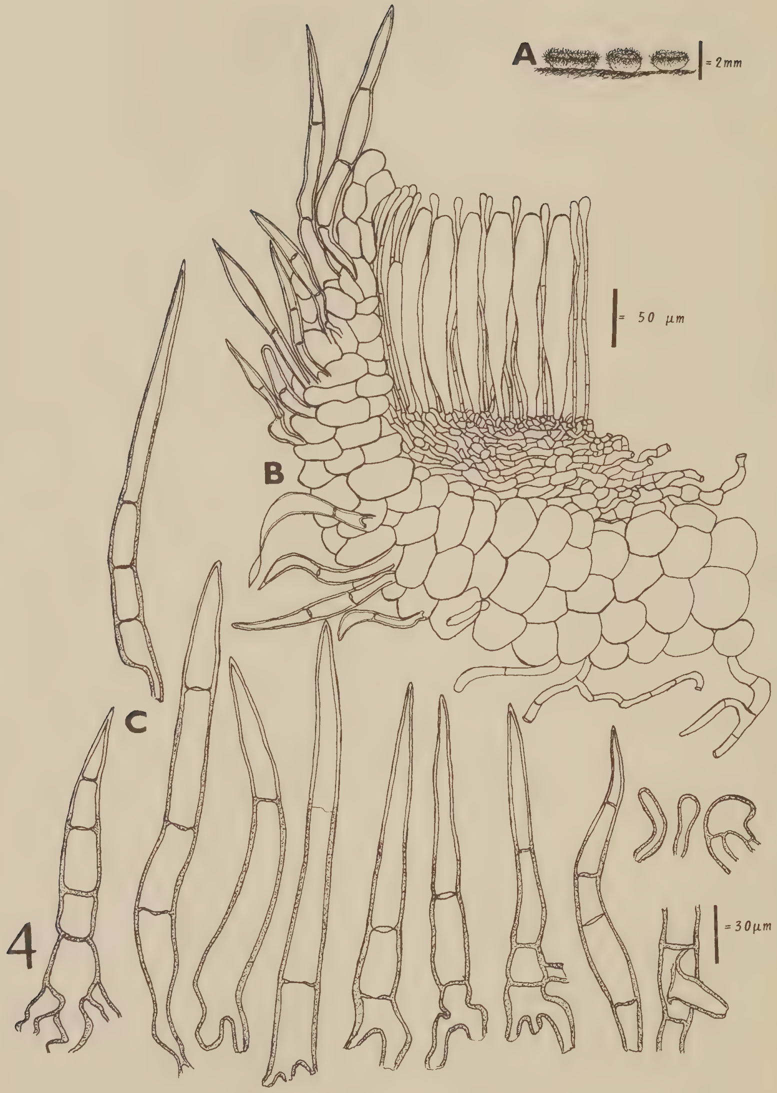
A
= 2mm
= 50 μm
B
C
4
= 30μm

Fig. 4: Cheilymenia liskae. A. apothecia; B. section of the marginal part of the apothecium; C. hairs. (Holotype PRM).

cyanophilis, rotundatis vel elongatis usque irregularibus, sed etiam saepe reticulum haud completum formantes; verrucae 0.1-1.5 µm diam., 0.1-0.5 µm altae. Paraphyses filiformes, 3 µm crassae, septatae, apice 6-9 µm dilatatae, succo aurantiaco impletae.
Habitat: fimicola.
Holotypus: Spitsbergen occidentalis, Svalbard, Kongress, in fimo, 21 VII. 1988 leg. J. Liška et Z. Soldán. (Holotypus PRM, isotypus BRA asservantur).

Apothecia 1-5 mm diam. (0.75-3.50 mm when dried), at first subglobose and closed, becoming shallow cupulate to flattened, hymenium orange (orange-olivaceous when dried), external surface concolorous, covered with short, densely aggregated, irregularly curved pale hairs, which are brownish at their base, giving a brownish colour to the apothecial margin. Rooting marginal hairs 90-240 x 10-30 µm, rigid, straight or curved, with few (1-4) septa, pointed above, thick-walled (walls 1.5-3 µm thick) , yellow-brown but usually with the upper third colourless, the base often rooting, bifurcate or with three, rarely four roots, sometimes simply attenuated, arising deep amongst the excipular cells. Hairs towards the base of the apothecia shorter, with thinner walls (0.7-1.5 µm thick), mixed with juvenile, clavate yellow-brown hairs. Ectal excipulum a textura globulosa-angularis, composed of 3-4 rows of cells which are slightly clavate at the margin of the apothecia, larger and subglobose near the base, 45-65 µm diam.,subhyaline. Medullary excipulum composed of hyaline, septate, interwoven, mostly horizontally arranged hyphae which are (4-)7-9 µm diam., occasionally inflated up to 15 µm diam. Hypothecium not clearly differentiated, composed of narrower hyphae and smaller cells. Asci 150-180 x (18-)19.5-25(-27) µm, eight spored, broadly cylindric, usually attenuated above, with apex obtuse or truncated, the base shortly attenuated, simple, Ascospores uniseriate or biseriate, ellipsoid, (18-)19.5-21(-22.5) x 10.5-12(-13.6) µm, subhyaline, without guttules, with a yellow refractive colour when stained in CB; perisporium loosening, covered by cyanophilic irregular crests, which occasionally form a fine, incomplete reticulum, or with rounded warts 0.1-1.5 µm diam. and 0.1-0.5 µm high. Paraphyses filiform, 3 µm thick, septate, with yellow-orange apices enlarged to 6-9 µm.
Habitat: coprophilous.
Holotype: West Spitsbergen, Svalbard, Kongress, on dung (probably of reindeer), 21 VII. 1988 leg. J.Liška and Z. Soldán. (Holotype PRM, isotype BRA).

The present species resembles _C. rubra_ especially with regard to the densely arranged hairs near the margin and ascospore characters. However, the marginal hairs of _C. rubra_ are brownish throughout, with a much simpler base and usually thicker walls. The marginal hairs of _C. liskae_ are hyaline in their upper part. Moreover, the ascospores of _C. liskae_ are broader and bear higher, coarser warts. In addition, the cells of the ectal excipulum of _C. rubra_ are much larger, the asci are shorter and narrower, the ascospores uniseriate and the apices of the paraphyses narrower. The species also differ in habitat.

C. humarioides differs clearly from *C. liskae* in having much larger ascospores with three-layered walls and larger warts on the perisporium. *C. pseudohumarioides* differs in having broader ascospores with a more finely ornamented perisporium (the warts are much lower and smaller) and, especially, in the appearance of the apothecia, which are only sparsely covered by hairs. Moreover, the hairs in *C. pseudohumarioides* have thinner walls and a simpler base and the asci are narrower and contain uniseriate ascospores.

All taxa discussed in the present paper are quite distinct from *C. coprinaria*, especially with regard to the shape, colour and length of the hairs. In the course of the investigation of the type and other material I have found that *C. coprinaria*, as commonly interpreted, is, in fact, a complex of several species. These include *Cheilymenia magnipila* J.Moravec (1969), *C. megaspora* (Gamundí) J.Moravec (1988) and an undescribed species for which a description is currently being prepared.

Cheilymenia aurea Boud. may also be related to *C. coprinaria*. However, it is insufficiently known as the type collection contains no apothecia and no other material is preserved in Boudier's herbarium in PC. According to Boudier (1905-1910), *C. aurea* has long, narrower (270-680 x 10-15 µm), brown hairs. *Cheilymenia coprinaria* sensu Boudier (1905-1910) somewhat resembles *C. rubra*. However, no material of the collection illustrated by Boudier is preserved in PC.

The type of *Arhenia fimicola* de Not.et Bagl., identified with *C. coprinaria* by Dennis (1978), has not been examined. However, it may not be identical with the type of *C. coprinaria* (see J.Moravec 1989) as it is described as having larger ascospores (Dennis 1978).

Cheilymenia fraudans (Karst.)Boud., which has excipular structure and hairs similar to those of the species under discussion, in fact differs from all these taxa in having smaller and more subglobose ascospores which bear a dense subreticulate ornamentation of the perisporium, narrower asci and hairs. Furthermore, due to the absence of the yellow refractive colour of mature ascospores when stained with CB (see also the description and drawings in J.Moravec 1989), it seems likely that *C. fraudans* belong to *Scutellinia* sect. *Minutae* Svrček (1971).

During the course of this study, isotype material (OSU) of *Cheilymenia alleghenensis* Denison (1964) was examined. Mature ascospores of *C. alleghenensis* are without the yellow refractive colour when stained with CB and this species proves to belong in the genus *Scutellinia* (Cooke) Lamb. sect. *Minutae* Svr. I, therefore, propose the new combination:

Scutellinia alleghenensis (Denison) J.Moravec **comb. nov.**

Basionym: *Cheilymenia alleghenensis* Denison, Mycologia 56: 732, 1964.

The ascospores of *S. alleghenensis* have a similar ornamentation to those of a similar *Scutellinia convexa* (Velen.) Svr. but are much smaller, 12-16.5 x (7.5-)8-9(-10) µm. Indeed, they are smaller than measured and published by Dennison (1964). They are similar in size to those of *Scutellinia minutella* Svr.et J.Mor. but their ornamentation consists of warts and crests which are much coarser than in that species. The species of *Scutellinia* which have ascospores with a

separable perisporium and are referred to the sections Minutae and Pseudocheilymeniae Svr. (including Scutellinia crucipila (Cooke et Phill.in Cooke) J.Moravec (1984)) may, in my opinion, represent a distint genus.
The revision has confirmed my opinion (J.Moravec 1984) that the genus Cheilymenia as commonly interpreted is a complex of several distinct genera and a proposal for a new division of this genus is being prepared.

ACKNOWLEDGEMENTS

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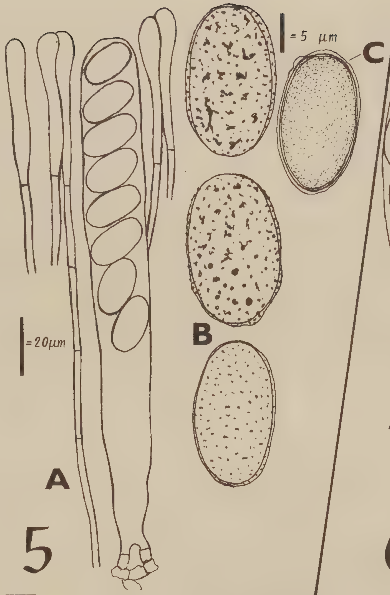
Figs 5-8: Microfeatures of Cheilymenia. 5: C. rubra. A. ascus and paraphyses; B. ascospores under oil immersion + CB; C. an optical section of the ascospore. 6: C. liskae. A. asci and paraphyses; B. ascospores. 7: C. pseudohumarioides. A. asci and paraphyses; B. ascospores; C. an optical section of the ascospore. 8: C. humarioides. A. ascospores; B. an optical section of the ascospore.- Holotypes.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B
C
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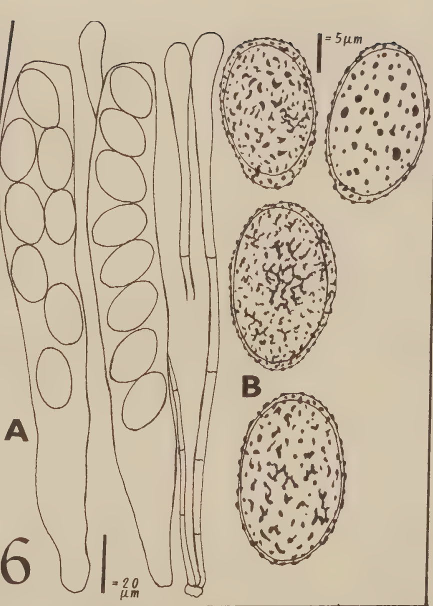
=20µm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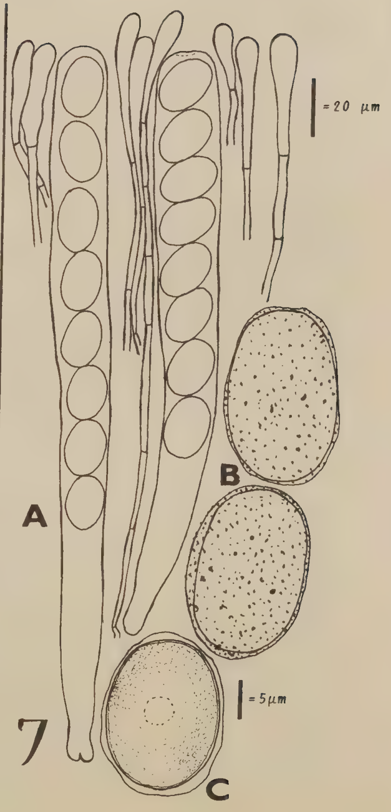
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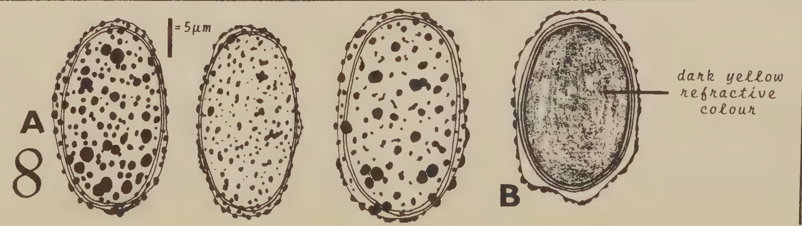
8
A
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dark yellow refractive colour

9

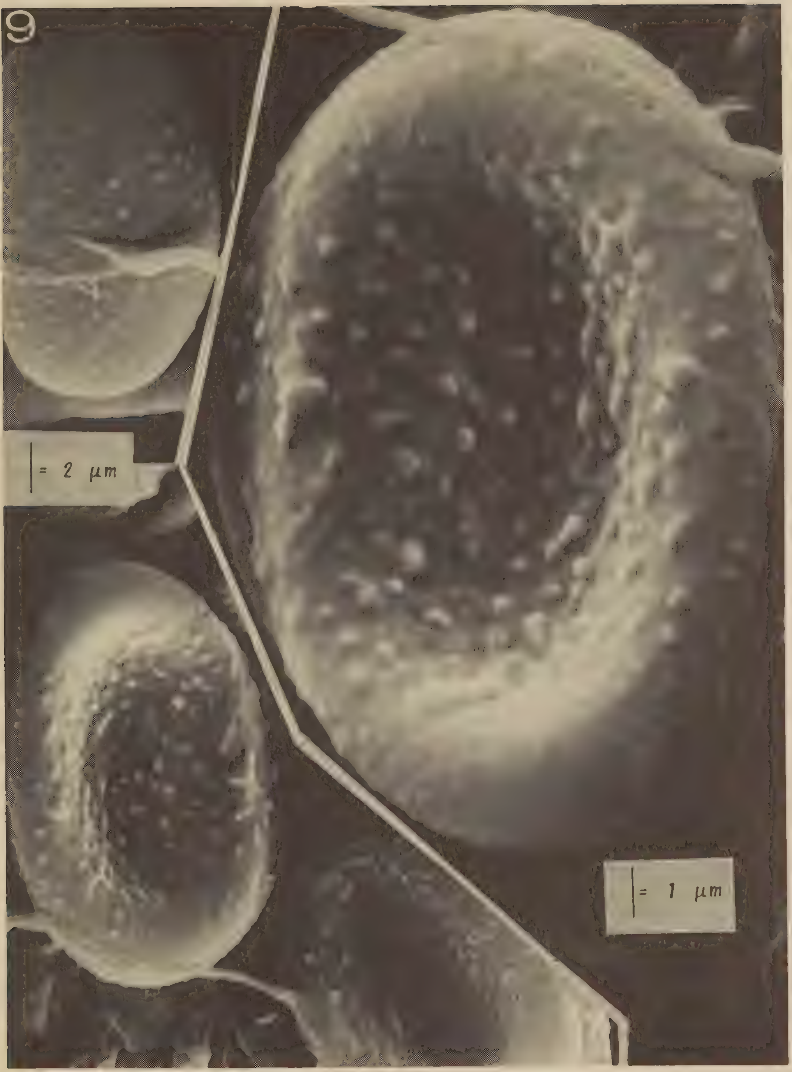

Fig. 9: SEM of ascospores of Cheilymenia rubra, Holotype (K).

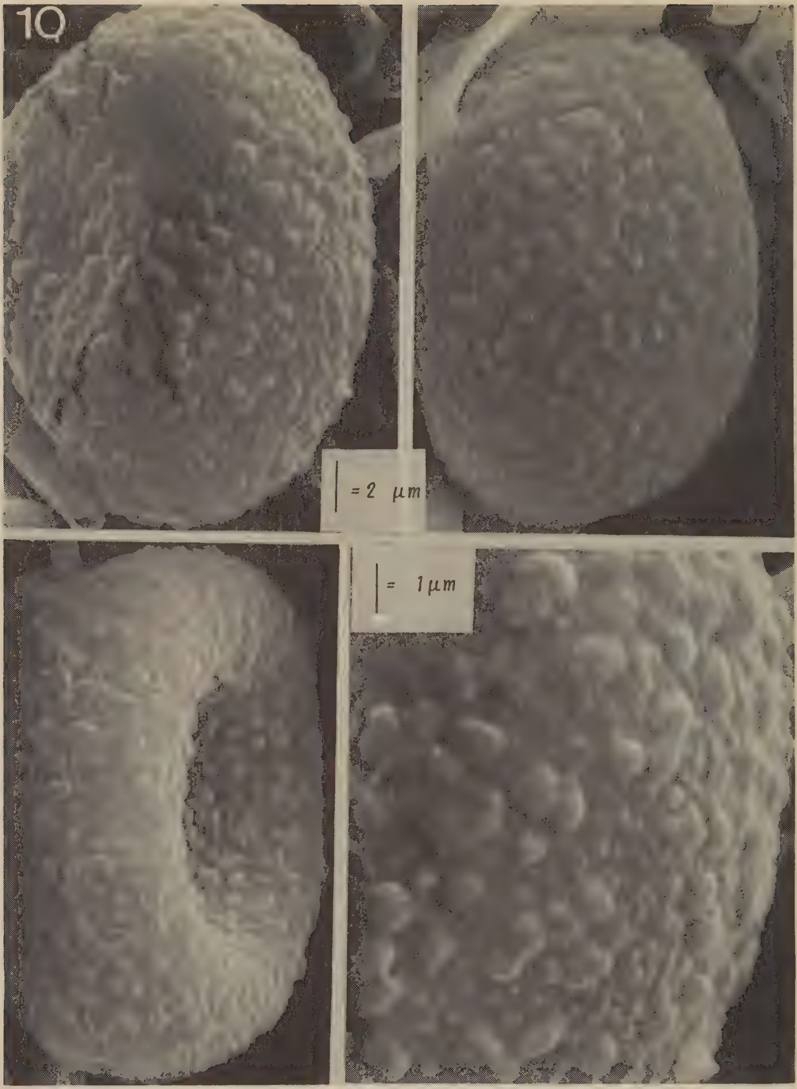

Fig. 10: SEM of ascospores of Cheilymenia humarioides. Holotype (LPS).

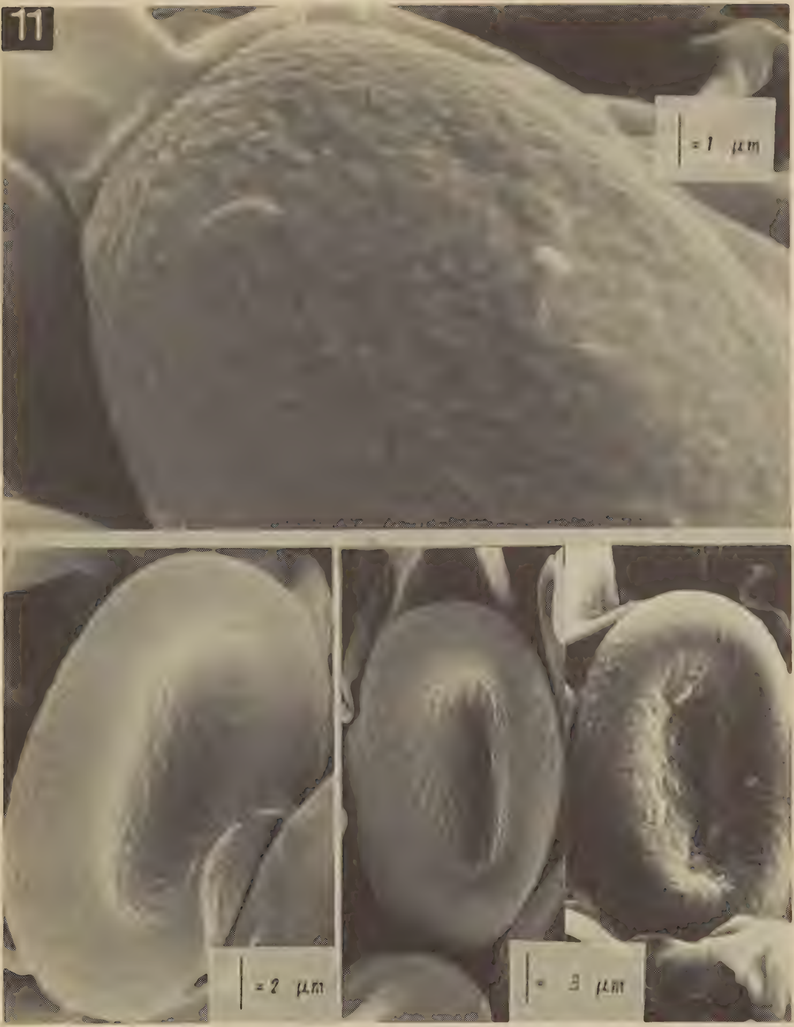
11
= 1 μm
= 2 μm
= 3 μm

Fig. 11: SEM of ascospores of *Cheilymenia pseudohumarioides*. Holotype (C).

12

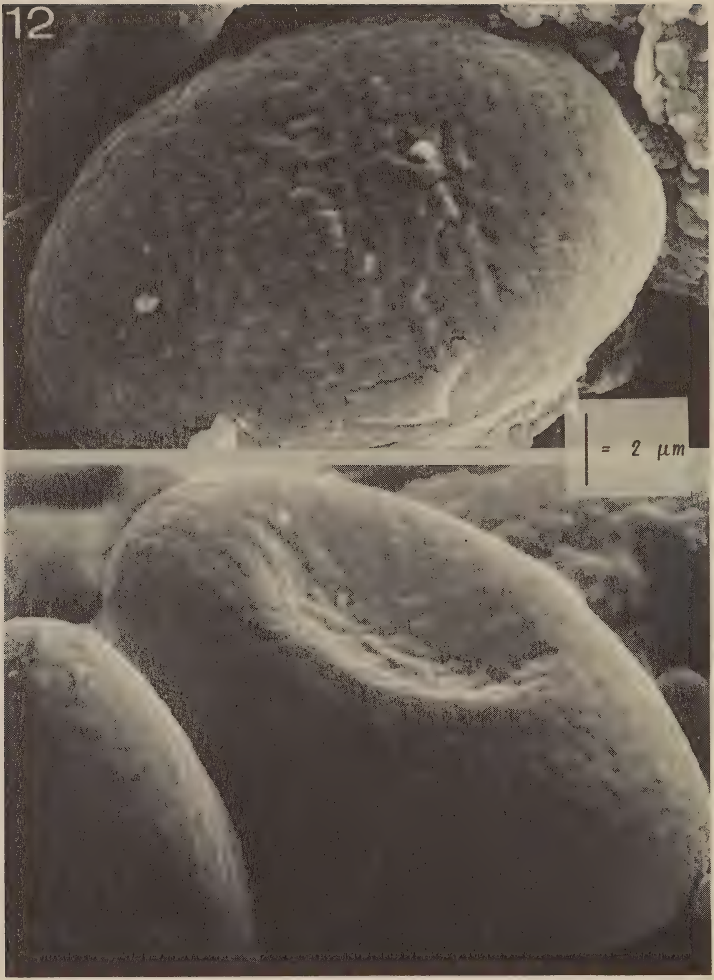

Fig. 12: SEM of ascospores of Cheilymenia liskae. Holotype (PRM).

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SIZE AND SHAPE OF UREDINIOSPORES AS INFLUENCED BY AMBIENT RELATIVE HUMIDITY*

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ABSTRACT

Urediniospores of 21 rust species were examined under natural and/or artificial conditions to determine their size and shape when hydrated or dehydrated. Urediniospores under room conditions were 70-80% of their hydrated size and were indented or collapsed. Shape of dehydrated urediniospores varied among species depending on several factors, primarily the distribution and number of germ pores. Urediniospores of _Puccinia graminis_, _P_. _recondita_, and _Uromyces appendiculatus_ were manipulated experimentally to determine the relative humidity (r.h.) at which they would assume their expanded or collapsed shape. The three species responded differently to the r.h. levels studied. Urediniospores of

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*Based on an undergraduate research project by the junior author at North Dakota State University, Fargo, ND. Journal Paper No. 5655, Oklahoma Agricultural Experiment Station, and Journal Paper No. 1763, North Dakota Agricultural Experiment Station

P. graminis were expanded at 92.0% r.h. and above, were partially collapsed at 80.3% r.h. and were entirely collapsed at 75.8% r.h. P. recondita urediniospores were expanded at 92.0% r.h. and above, but were collapsed at 80.3% r.h. U. appendiculatus urediniospores were expanded at 100 and 96.9% r.h., were only partially collapsed at 92.0% r.h., and were entirely collapsed at 80.3% r.h. When placed into 100% r.h. collapsed urediniospores of these species absorbed moisture and regained their expanded size and shape usually within 1-2 min.

INTRODUCTION

Most descriptions of rust urediniospores are based on spores mounted in aqueous solutions such as chloral hydrate or lactophenol (Arthur, 1934; Cummins & Hiratsuka, 1983). Such descriptions most commonly characterize urediniospores as globoid to ellipsoid, although fusiform, lanceolate, reniform, or other configurations are not uncommon. Distribution and number of germ pores have also been described for most urediniospores. Germ pores may be scattered, bizonate, equatorial, supraequatorial, subequatorial, or basal near the hilum, with both their numbers and distribution varying among and sometimes within species (Cummins, 1936).

Seldom have dehydrated urediniospores been described. If collapsed or indented areas on dry urediniospores are observed they are often attributed to dehydration damage and dismissed as artefacts of preparation (Littlefield & Heath, 1979). Hardwick et al. (1975), however, contended that the collapsed, "doughnut" form of Uromyces appendiculatus is natural and occurs under normal atmospheric conditions. Cummins (1935) noted that when hydrated urediniospores of Puccinia spp. exposed to an alcohol solution collapsed into characteristic configurations that were related to the number and arrangement of germ pores. Jones (1971) suggested that depressions in the surface of Uromyces dianthi urediniospores are associated with underlying weak germ pore regions of the wall. In a survey of 150 collections of Melampsora medusae, M. occidentalis and M. abietis - canadensis the length of dehydrated urediniospores examined by scanning electron microscopy was noted to be

39% less than that of hydrated spores (Stack and Ostry, 1989). Strobel (1965) noted that dehydrated urediniospores of Puccinia striiformis were about 50% the size of hydrated spores. The reduced size and weight of Puccinia graminis f. sp. tritici urediniospores caused by dehydration, and their effects on rate of fall in still air were studied by Weinhold (1955). The collapse and resulting characteristic shape of dehydrated smut teliospores has been used to help differentiate Tilletia species in contaminated grain samples (Trione & Krygier, 1977).

The objectives of this study were threefold: 1) to determine the size and shape of the urediniospores of various rusts under natural atmospheric conditions; 2) to determine if the pattern of wall collapse, if any, is related to the number and/or distribution of germ pores or any other factors; and 3) to determine the relative humidity levels at which selected rust urediniospores will assume either their collapsed or their expanded shape.

MATERIALS AND METHODS

Urediniospores of 21 rust species in 8 genera, either dry or mounted in aqueous chloral hydrate solution, were examined and measured. For some photographs enhanced contrast was required. This was achieved by mounting urediniospores in lactophenol plus .05% (w/v) cotton blue. Fresh urediniospores from glasshouse-grown plants (6 species) and urediniospores from herbarium material (15 species) were used (Table 1). All herbarium specimens came from the North Dakota State University Plant Pathology Department herbarium. Specimens were selected to provide a variety of germ pore arrangement, urediniospore shape and size, and wall thickness. Length and width dimensions were recorded for 30 urediniospores of each species examined, both in hydrated and dehydrated states. Patterns of collapse and general shape of the dry urediniospores were determined. An Olympus interference contrast microscope, model BH-2, and Kodak Plus X Pan film were used throughout the study.

To determine the relative humidity levels at which various urediniospores would assume their collapsed or expanded condition, three rust species were utilized, Puccinia graminis, Puccinia recondita and Uromyces appendiculatus. Small humidity chambers were constructed on 25 x 75 x 1 mm glass microscope slides to allow light microscopic examination of spores without disturbing the controlled relative humidity environment within. Each chamber, 2.5 X 5.0 cm, was constructed from four pieces of 5mm outer-diameter glass tubing cemented together and to an underlying microscope slide with clear epoxy cement. Within each chamber two short pieces of 4 mm diameter glass tubing were also cemented to the microscope slide. These pieces provided the base for a small (10 X 12 mm) observation platform (a piece of a coverglass) onto which the urediniospores were sprinkled. To prevent condensation on that platform, each side of it was coated with a thin film of an anti-fog agent (Anti-Fog°, World Optical, Arlington, TX) prior to adding the urediniospores. Urediniospores freshly collected from glasshouse grown plants were used exclusively.

Solutions of K_2SO_4, KNO_3, $(NH_4)_2SO_4$, and NaCl were used to establish relative humidity (r.h.) levels of 96.9, 92.0, 80.3, and 75.8%, respectively, at 25°C within the chambers (Wexler & Hasegawa, 1954). Distilled water was used to establish a humidity level of 100%. A small amount of these liquids (0.8 ml) was added to the humidity chambers containing the urediniospores. The humidity chambers were then covered with a 25 x 60 mm coverglass coated with anti-fog agent. The coverglass was sealed to the chamber with petroleum jelly to prevent loss of moisture.

Humidity chambers were held at 25°C on a temperature controlled hotplate in a 20-22°C room for at least 24 h to achieve the desired humidity levels. Following that equilibration urediniospores were examined microscopically and photographed. The temperature under the light microscope was also held constant at 25°C by use of heat absorbing blue filters placed between the light source and the condenser. Light intensity and iris diaphragm settings were predetermined in order to maintain a constant temperature among experiments. The temperature was monitored with a calibrated glass bead thermistor (accurate to ± 0.1°C) placed on the field diaphram of the microscope light source. To approximate the percentage of urediniospores expanded, collapsed, or partially collapsed, 100 spores were counted and the individual configuration of each spore was recorded for each humidity chamber. Three replicate trials were made with all three rust fungi at all humidity levels, each time using fresh urediniospores collected from glasshouse-grown material.

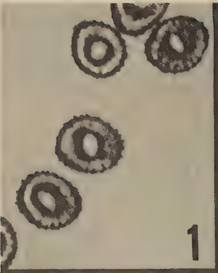
Table 1. List of species examined

Urediniospores obtained from fresh glasshouse-grown material
- *Melampsora lini* (Ehrenb.) Lev.
- *Puccinia coronata* Cda.
- *Puccinia graminis* Pers.
- *Puccinia recondita* Rob. ex Desm.
- *Uromyces appendiculatus* (Pers.) Unger
- *Uromyces striatus* Schroet.

Urediniospores obtained from herbarium specimens
- *Hemileia vastatrix* Berk. & Br.
- *Melampsora medusae* Thuem.
- *Pileolaria brevipes* Berk. & Rav.
- *Puccinia caulicola* Tracy & Gall
- *Puccinia helianthi* Schw.
- *Puccinia minussensis* Thuem.
- *Puccinia purpurea* Cke.
- *Puccinia sporoboli* Arth.
- *Puccinia tanaceti* DC.
- *Puccinia tumidipes* Pk.
- *Tranzschelia pruni-spinosae* (Pers.) Diet.
- *Uredinopsis osmundae* Magn.
- *Uromyces plumbarius* Pk.
- *Uromyces silphii* Arth.
- *Uropyxis amorphae* (Curt.) Schroet.

RESULTS

Dimensions of rust urediniospores examined in both hydrated and dehydrated states and the percentage reduction in size of dehydrated spores are given in Table 2. As would be expected, the dehydrated spores were nearly always smaller than those mounted in chloral hydrate. Urediniospores typically dehydrated to 70-80% of their hydrated size. Extremes in shrinkage observed were 67.9% width and 71.1% length, compared to hydrated spores. It appeared that in some rusts, e.g. *Uredinopsis osmundae* and *Pileolaria brevipes*, the width of dehydrated urediniospores did not change, or even increased, while the length was reduced.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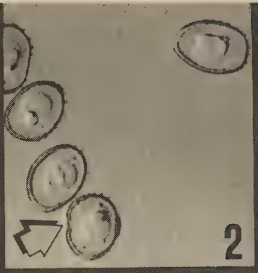
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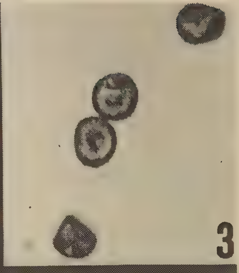
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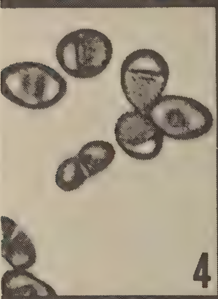
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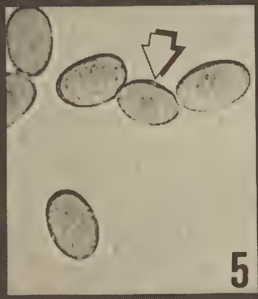
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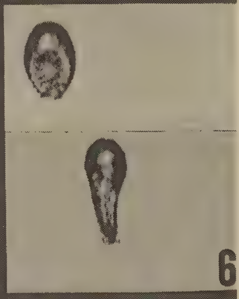
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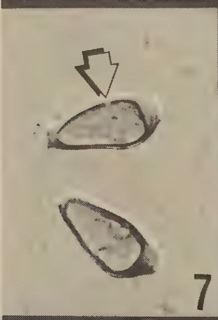
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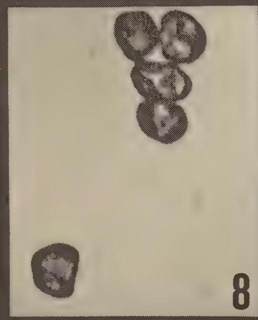
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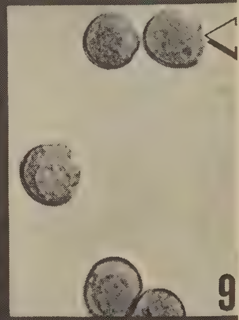
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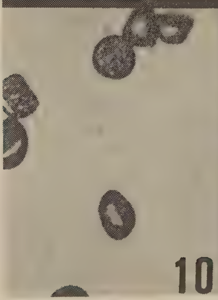
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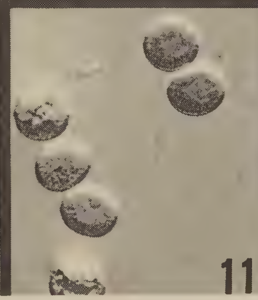
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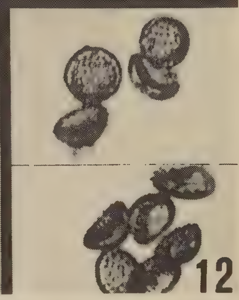
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Urediniospores of _M_. _lini_, _P_. _coronata_, _P_. _graminis_, _P_. _recondita_, _U_. _appendiculatus_ and _U_. _striatus_ that had fallen free of the uredinia onto the leaf surface of

FIGURE LEGENDS

Note: All micrographs of dehydrated spores were made from dry spores with no mounting medium or coverglass applied. All hydrated spores were mounted in aqueous, saturated chloral hydrate, and covered with a coverglass. Experimentally dehydrated and rehydrated spores (Figs. 14-21) were photographed unmounted on dry coverglasses located within controlled humidity microchambers. All figures X325.

Fig. 1. Dehydrated urediniospores of _Uromyces appendiculatus_. Note their characteristic "doughnut" shape, the result of wall collapse in the region of the two equatorial germ pores.

Fig. 2. Hydrated urediniospores of _Uromyces appendiculatus_. Note their typical ovoid shape and larger size compared to dehydrated spores, Fig. 1. Germ pore (arrow).

Fig. 3. Dehydrated urediniospores of _Uromyces striatus_. Note collapsed areas which apparently are centered around the equatorial germ pores.

Fig. 4. Dehydrated urediniospores of _Puccinia graminis_. Note the equatorial "valley" that results from coalescence of collapsed wall areas around the 3-4 equatorial germ pores.

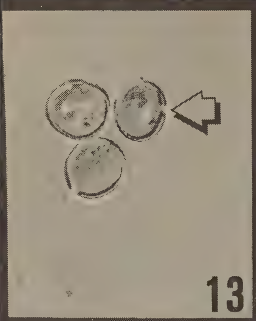
Fig. 5. Hydrated urediniospores of _Puccinia graminis_. Germ pore (arrow).

Fig. 6. Dehydrated urediniospores of _Tranzschelia pruni-spinosae_.

Fig. 7. Hydrated urediniospores of _Tranzschelia pruni-spinosae_. Note the thickened apical wall areas that apparently prevent collapse of the cell wall in those same regions close to the germ pores (arrow).

Fig. 8. Dehydrated urediniospores of _Puccinia recondita_. Note the localized regions of cell wall collapse around the germ pores.

Fig. 9. Hydrated urediniospores of _Puccinia recondita_. Germ pore (arrow).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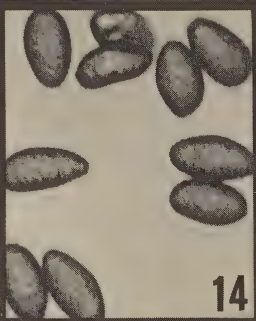
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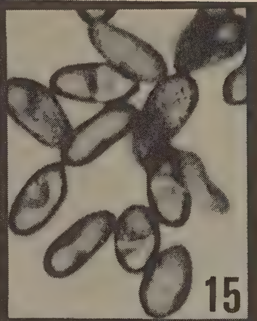
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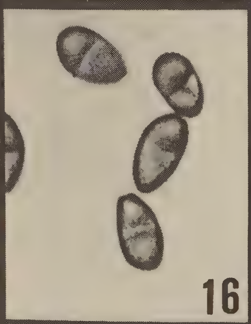
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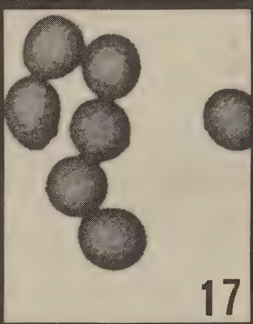
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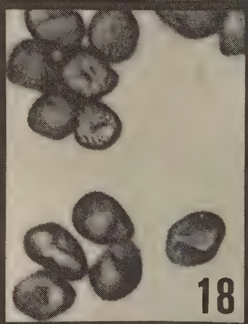
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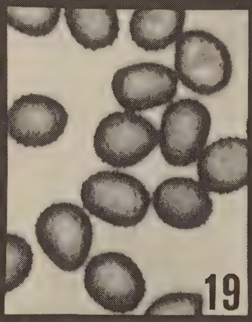
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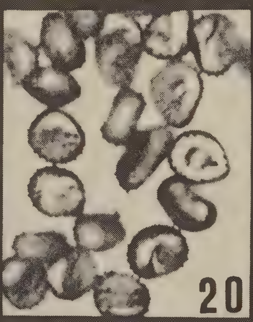
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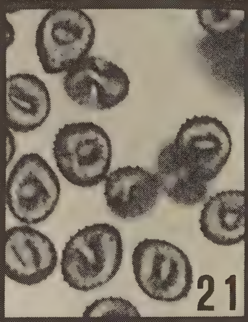
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Fig. 10. Dehydrated urediniospores of Melampsora lini. Note the localized regions of cell wall collapse around the scattered germ pores.

Fig. 11. Hydrated urediniospores of Melampsora lini.

Fig. 12. Dehydrated urediniospores of Puccinia caulicola. The bowl shape of these spores results apparently from wall collapse around the basally located germ pores.

Fig. 13. Hydrated urediniospores of *Puccinia caulicola*. Germ pore (arrow).

Fig. 14. Experimentally rehydrated urediniospores of *Puccinia graminis* at 100% r.h. Note the expanded ellipsoid shape and the absence of wall depression.

Fig. 15. Partially dehydrated urediniospores of *Puccinia graminis* at 80.3% r.h. Note the partial collapse of the cell wall in distinct regions, but the lack of coalescence of those depressions to form an equatorial "valley". Compare to totally collapsed spores, Fig. 16.

Fig. 16. Totally collapsed, dehydrated urediniospores of *Puccinia graminis* at 75.8% r.h. Compare to the naturally dehydrated urediniospores in Fig. 4.

Fig. 17. Experimentally rehydrated urediniospores of *Puccinia recondita* at 100% r.h.

Fig. 18. Experimentally dehydrated urediniospores of *Puccinia recondita* at 80.3% r.h. Compare to the naturally dehydrated urediniospores in Fig. 8.

Fig. 19. Experimentally rehydrated urediniospores of *Uromyces appendiculatus* at 100% r.h.

Fig. 20. Partially dehydrated urediniospores of *Uromyces appendiculatus* at 92% r.h. Note the small depressions on the surface of several spores.

Fig. 21. Collapsed, dehydrated urediospores of *Uromyces appendiculatus* at 80.3% r.h. Compare to the naturally dehydrated urediniospores in Fig. 1.

glasshouse grown plants were always collapsed when the leaves were viewed by epi-illumination light microscopy. Urediniospores within uredinia were also typically collapsed except for those deeply enmeshed in the central areas of uredinia.

Urediniospores with two opposite, equatorial germ pores (*Puccinia helianthi*, *Uromyces appendiculatus*, *U. plumbarius*) typically collapsed into the 'doughnut' shape as described by Hardwick *et al*. (1978) for *U. appendiculatus* (Figs. 1,2). *U. silphii*, which has two supraequatorial germ pores, appeared to behave somewhat differently. Although the "doughnut" shape commonly occurred in the urediniospores of *U. silphii*, other configurations, e.g. bowl-shaped, or simply irregular patterns of collapse were also noted.

Table 2. Average dimensions (um) of urediniospores studied[a].

Species	Hydrated state; mounted in chloral hydrate	Dehydrated state; on dry glass slides	Percentage value dehydrated spores compared to hydrated spores	
			Width[c]	Length[c]
Urediniospores with 2 equatorial germ pores[b]				
Puccinia helianthi	26.0 X 32.5	24.9 X 27.5	98.5	84.6
Uromyces appendiculatus	20.4 X 27.5	17.6 X 21.0	93.1	86.9
Uromyces plumbarius	19.0 X 23.7	18.1 X 20.2	95.3	85.2
Urediniospores with 2 supraequatorial germ pores				
Uromyces silphii	19.5 X 23.6	17.6 X 21.0	90.3	88.9
Urediniopores with >2 equatorial germ pores				
Puccinia graminis	18.5 X 32.2	14.8 X 22.9	80.0	71.1
Puccinia tanaceti	24.5 X 32.6	18.3 X 26.2	74.7	80.4
Tranzschelia pruni-spinosae[d]	19.1 X 34.8	16.0 X 32.5	83.8	93.4
Uromyces striatus	17.7 X 19.3	15.9 X 18.6	89.8	96.4

Table 2 continued...

Urediniospores with numerous, scattered germ pores				
Melampsora lini	18.2 X 21.5	14.2 X 19.2	78.0	89.3
*Melampsora medusae**	20.1 X 32.6	13.9 X 25.4	69.1	77.9
Puccinia coronata	21.6 X 26.1	15.2 X 19.0	70.4	72.8
Puccinia minussensis	22.6 X 24.6	17.0 X 21.2	75.2	86.2
Puccinia purpurea	26.6 X 34.7	22.9 X 28.8	86.1	83.0
Puccinia recondita	21.3 X 25.3	16.6 X 19.9	77.9	78.7
Uropyxis amorphae	16.2 X 20.8	11.0 X 15.5	67.9	74.5
Urediniospores with 2-6 germ pores near base				
Pileolaria brevipes	21.9 X 44.1	23.5 X 37.5	108.0	85.0
Puccinia caulicola	21.4 X 23.8	18.6 X 20.9	86.9	87.8
Puccinia sporoboli	26.0 X 27.3	20.8 X 22.7	80.0	83.2
Urediniospores with 8 germ pores, 4 in each of 2 transverse bands				
Puccinia tumidipes	22.8 X 33.7	7.7 X 27.8	77.6	82.5

continued on next page...

Table 2 continued...

Urediniospores with 4 germ pores; 2 much above and 2 much below equator				
Uredinopsis osmundae	12.9 X 45.4	13.7 X 40.2	106.0	88.5
Urediniospores reniform to pyramidal, with 3 or 4 germ pores typically at the acute-angle regions of the spore				
Hemileia vastatrix[f]	20.9 X 29.7	17.7 X 23.8	84.7	80.1

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[a] All size measurements based on 30 urediniospores per species.

[b] Germ pore descriptions based on Arthur (1934), Cummins (1936), or our observations.

[c] Length is considered the side with the greater dimension, width the side with the smaller dimension. In a collapsed state, a urediniospore may measure smallest on one side where it would not when expanded.

[d] Some germ pores supraequatorial; a few subequatorial.

[e] Typically 2 germ pores on apical shoulders; occasionally with 1 more near the base.

[f] Germ pores are extremely difficult to observe in the thick walled urediniospores of H. vastatrix. Germ pore locations were assumed to be restricted to the locations of germ tubes illustrated by Ward (1882) and Harr and Guggenheim (1978).

Urediniospores of species with more than 2 equatorial germ pores tended to collapse around the equator where the pores are located. Urediniospores with 3-5 equatorial germ pores showed variations in collapse depending on the number of germ pores as well as wall thickness and spore shape. *Puccinia tanaceti*, with three equatorial pores, appeared more on less elliptical, with 3 indented areas, giving a triangular configuration in optical section. A somewhat similar appearance, i.e., 2-4 localized depressions around the equator, typified the globoid spores of *Uromyces striatus* (Fig. 3). Some urediniospores of that species, however, collapsed into a "doughnut" configuration, which suggests those particular spores had only two equatorial germ pores. *P. graminis* with 4-5 equatorial germ pores collapsed mostly at the equator, forming a distinct "valley" across the middle of the spore with noncollapsed areas on either side (Figs. 4,5). The configuration of dehydrated urediniospores in *Tranzschelia pruni-spinosae* may be more dependent on spore wall thickness than on germ pore arrangement. Spores of this species collapsed throughout, including the germ pore regions, except in the apical areas where a thickened cell wall is present (Figs. 6,7).

Urediniospores with scattered, numerous germ pores tended to have a more irregular pattern of collapse, e.g. *P. recondita* and *Melampsora lini* (Figs. 8-11). Some showed small indentations across and around the spore, and others had larger collapsed areas on one side. The irregularity of collapse seen in these urediniospores is consistent with what would be expected from the scattered arrangement of germ pores.

Urediniospores with pores near the hilum, e.g. *Puccinia caulicola* and *Puccinia sporoboli*, collapsed into a 'bowl' shape, with one large indentation, upon dehydration (Figs. 12,13). Presumably the indented area occurred in the hilum region, although this was not proven.

The patterns of collapse in *Hemileia vastatrix*, *Melampsora medusae* and *Uredinopsis osmundae* were difficult to categorize. In these rusts urediniospores were variously shrunken when dehydrated, *M. medusae* more so than the other two. The shrinkage was more or less uniform throughout, with no marked depressions around germ pore regions.

When maintained under the controlled humidity conditions P. graminis urediniospores did not collapse at 100, 96.9, and 92.0% r.h., (Fig. 14). At 80.3% r.h., 81% of the urediniospores were collapsed to the extent that the characteristic "valley" could be seen across the spore; 19% were partially collapsed to the extent that indentations in the wall were evident but no "valley" was visible (Fig. 15). Nearly all urediniospores of P. graminis were collapsed at 75.8% r.h. (Fig. 16). At 100, 96.9, and 92.0% r.h. P. recondita urediniospores remained expanded with no visible signs of collapse (Fig. 17). All urediniospores of P. recondita were collapsed at 80.3% r.h. and appeared as irregularly collapsed spheres (Fig. 18). U. appendiculatus urediniospores were not collapsed at 100 and 96.9% r.h. (Fig. 19). At 92.0% r.h. those urediniospores showed various configurations, being 2% fully expanded, 21% partially collapsed but not "doughnut" shaped, and 77% collapsed to the characteristic "doughnut" configuration (Fig. 20). All urediniospores of U. appendiculatus were collapsed into the "doughnut" shape when held at 80.3% r.h. (Fig. 21).

Expanded, freshly collected urediniospores from leaf pustules assumed their characteristic dehydrated configuration in as little time as 30 sec to 1 min when placed onto a microscope slide at laboratory, ambient r.h.; conversely, dehydrated spores regained their characteristic hydrated configuration within 1-2 min when placed in a saturated atmosphere. These times were typical of spores individually situated on the microscope slide; spores in clusters required greater lengths of time to respond, particularly to rehydrate to their fully expanded state.

DISCUSSION

Light microscopy showed that rust urediniospores do indeed assume collapsed configurations under certain natural environmental conditions. Those shapes can differ markedly from the shapes of hydrated spores, which are generally used to study spore morphologoly. Urediniospores can change from their hydrated to their dehydrated configuration, or vice versa, within 1-2 min when placed in the appropriate atmospheric environment. Results of this study suggest that several aspects of rust taxonomy, morphology and aerobiology may be significantly influenced by the effects of atmospheric relative humidity.

Urediniospore size is a major criterion when identifying rust species. The use of scanning electron microscopy in such determinations can be inaccurate, or misleading at best, if the shrinkage effect is not taken into account. Identification of Melampsora spp. on Populus spp. by scanning electron microscopy of urediniospores required that shrinkage factors be determined and calculated into the data when species were being determined (Stack and Ostry, 1989); otherwise, serious errors would result.

Urediniospore germ pore regions are considered to be areas where the spore wall is weakened (Jones, 1971; Bennell and Henderson, 1978); it is thus reasonable to assume that spores would collapse at these weaker areas upon dehydration. If this is true, urediniospores with similar germ pore distribution and number should show a similar pattern of collapse, other factors being equal. Indeed, certain patterns of collapse could be noted which seem to correspond to germ pore number and arrangement. Species with 2 equatorial germ pores generally collapsed to the "doughnut" configuration; those with more than 2 equatorial germ pores collapsed around those pores to form a series of depressions, or when coalesced those depressions formed an equatorial "valley" across the spore. Those with basally located pores collapsed to form a "bowl" configuration. Spores with numerous, scattered germ pores collapsed in a more random, nonuniform manner. Exceptions such as H. vastatrix, M. medusae, U. osmundae, T. pruni-spinosae exist. Those urediniospores have either nonuniformly thick spore walls, or have germ pores restricted to rigid "corners" of the spores. It can be concluded from this study that the shape of dry urediniospores of many species is determined to a large extent by germ pore number and distribution, wall thickness, and possibly spore shape.

This study indicates that at humidity levels below 75-80% many urediniospores normally occur in their dehydrated configurations. Consequently, in many areas of the world those urediniospores are disseminated, not as round to oval spores, but as irregularly shaped, indented structures. Some of the theoretical advantages of this fact were discussed by Hardwick *et al*. (1975). The state of the urediniospores on the leaf surface, whether hydrated or dehydrated, would depend upon the microclimate in the immediate vicinity. Urediniospores will attain complete expansion at 100% r.h. within only a few minutes after being held at 53% r.h. for 24 h.

The configuration of urediniospores could be significant in spore dispersal. The terminal velocity of falling spores, as defined by Stoke's Law (Gregory, 1973), is positively correlated to spore diameter. Consequently spore diameter can influence the horizontal distance that spores can travel in moving air. Most calculations of theoretical terminal velocity have been based on spore dimensions obtained from measurements of liquid-mounted spores examined by standard light microscopy. The smaller size and the variously convoluted shapes of dehydrated spores could affect their rate of fall. Results consistent with Stoke's Law were obtained by Ferrandino and Aylor (1984) for *U. appendiculatus* urediniospores. They observed that air-dried spores and fresh spores released into a settling chamber directly from the leaf surface settled at a rate of 0.86 and 1.08 cm s^{-1}, respectively. Presumably the faster rate of descent of fresh spores was related to their larger diameter, and perhaps a greater percentage of inflated, oval shaped spores compared to the percentage of dehydrated spores in their typical "doughnut" shape. Little is known, however, about the precise applicability of Stoke's Law to nonspherical spores or the effects of spore surface ornamentation on the rate of descent of spores in air (Gregory, 1973).

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NUCLEAR DNA, AN ADJUNCT TO MORPHOLOGY IN FUNGAL TAXONOMY

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ABSTRACT

Estimates of nuclear DNA in the haploid nuclei of two species of *Neurospora* (Ascomycetes) and 70 smut fungi (Ustilaginales) were calculated by microfluorometry. Haploid and diploid nuclei stained with Schiff reagent (pararosaniline) consistently fluoresced in proportion to DNA content. In using *Saccharomyces cerevisiae* Meyen ex Hansen as a bench mark organism (= 1.5 X 10^{10} daltons of DNA per haploid nucleus) it was estimated that haploid DNA among the 72 species ranged from 13.5 X 10^{9} to 95.8 X 10^{9} daltons. In nine species tested the average amounts of DNA in haploid and diploid nuclei closely approximated ratios of 1:2, respectively. The estimated amount for microconidia of *Neurospora crassa* Shear & Dodge by chemical analysis (Horowitz & Macleod, 1960) was confirmed by microfluorometry. Moreover, DNA replication occurred *after* karyogamy in fusion nuclei of both asci and teliospores. The potential use of genome size for taxonomic purposes as an adjunct to morphology is discussed.

INTRODUCTION

Thus far chromosome counts have had little application in fungal taxonomy, probably because the chromosomes of fungi generally are extremely small, they are hard to separate, and hence are difficult to count. For example, nuclei of smut fungi generally are so small that chromosome counts have yet to be categorically demonstrated with convincing photomicrographs. Consequently, the taxonomy of Ustilaginales likely will continue to be principally based on spore morphology, the way spores germinate, soral characteristics, and host specialization (Durán, 1988). However, Bosshard (1964) and Ruch (1966) have shown that the desoxyribonucleic acid (DNA) content of individual nuclei can be accurately measured with cytofluorometry, if an organism in which DNA has been determined by some other means is used as an internal standard, such as *Saccharomyces cerevisiae* Meyen ex Hansen. Since the chromosome number has been demonstrated only in random fungal taxa from time to time, it has thus far failed to figure prominently in the taxonomy of any of the major groups of fungi. As an alternative to the chromosome number, and/or in addition to it, the genome size (along with classical morphological criteria) should help the taxonomist to distinguish more critically between morphologically similar taxa, especially if the amounts of nuclear DNA can be shown to differ significantly.

Recently Cavalier-Smith (1985) summarized genome sizes for a large number of bacteria, protozoa, higher animals, plants, etc.; however, few estimates were indicated for fungi, apparently because thus far there have been relatively few quantitative studies of fungal DNA.

S. cerevisiae has been used for many years as a eukaryote of choice in genetic research, yet estimates of the genome size have varied considerably. Researchers have estimated the genome size by renaturation kinetics with very different results. Consequently, what genomic size to attribute to *S. cerevisiae* which was used as an internal standard in the present study was given careful consideration because it presented a dilemma. Based on the rate of DNA renaturation Bicknell & Douglas (1970) reported a minimum genome of 9.2 X 10^9 daltons, whereas Lauer, Roberts, & Klotz (1977) using both the diaminobenzoic acid and ethidium bromide methods to calculate amounts of DNA per cell concluded that a haploid nucleus contained 1.0 X 10^{10} ± 0.1 x 10^{10} daltons of DNA, adding ... 'recent DNA per cell studies from two other laboratories yielded a nuclear DNA content for *S. cerevisiae* of 8 x 10^9 to 9 x 10^9 daltons (Whitney & Hall, personal communication; Kaback, personal communication) in agreement with our values.' In contrast, Galeotti et al. (1981) reported 5.42 X 10^9 daltons for the haploid genome. With the exception of the latter estimate those indicated above agree with the recent one of Mortimer & Schild (1985) who calculated that recombinant lengths for the 16 chromosomes of *S. cerevisiae* totaled 3891 centimorgans (cM), i.e. about 9.34 x 10^9 daltons of DNA based on the DNA content of intervals of known genetic length. Their regression line showed a general correlation between chromosome size and recombination lengths.

Using orthogonal field alternating gel electrophoresis (OFAGE) to separate large chromosomal DNA's Carle & Olson (1987) estimated that chromosome XII, the largest in the genome, consisted of about 2.06 X 10^9 daltons of DNA, a figure which fell within a range of DNA values earlier reported for the same chromosome by Lauer et al. (1977). Using microfluorometric techniques to measure nuclear DNA and C. C. Lindegren's haploid alpha strain of *S. cerevisiae* (ATCC #10275) as an internal standard, we present herein estimates of nuclear DNA in two species of *Neurospora* (Ascomycetes) and 70 species of smut fungi (Ustilaginales).

MATERIALS AND METHODS

Considering that the estimates of Bicknell et al. (1970), Lauer et al. (1977), and Mortimer et al. (1985) were in large regard comparable, and since some decision had to be exercised in assigning a genome value to the internal standard, we settled for a genome size of 1.5 X 10^{10} daltons of nuclear DNA which is the mean for dividing cultures (1.0 x 10^{10} daltons being a 1 C value for non-dividing cultures reported by Lauer and co-workers in their 1977 paper.

Teliospores were streaked on 2% potato dextrose agar or 2% water agar. Those that germinated and others presumably in very early stages of the germination process but not showing germ-tubes, as well as the products of germination which consisted mostly of uninucleate sporidia, were smeared onto glass slides coated with Haupt's adhesive (Johansen, 1940) and fixed.

A microconidial strain of *Neurospora crassa* (stock #FGSC 2179) with mutant genes for peach/fluffy (Barratt & Garnjobst, 1949) was grown on neurospora culture agar (NCA). It was selected for study because the mutant genes eliminate production of macroconidia; moreover, uninucleate haploid microconidia are produced in profusion which auto-arrest as soon as formed. Material studied consisted of microconidia and mycelium removed from subcultures 4 days old, smeared onto slides coated with Haupt's adhesive and subsequently fixed. *Neurospora tetrasperma* (ATCC #38097) was subcultured on corn meal agar (CMA). Perithecia, mostly immature, were removed with microforceps from cultures 5-8 days old, squashed between two glass slides coated with Haupt's adhesive, fixed, and dried on a warming table at 45°C. Haploid and diploid strains of *S. cerevisiae*, ATCC #10275, and ATCC #26109, respectively, were subcultured on yeast malt agar (YMA). All subculturing was done at room temperature. Except for the teliospores of *Tilletia controversa* which were germinated at 4°C with 8 h of light and 16 h of darkness, those of all the other smut fungi were germinated at room temperature. All materials were fixed for 24 h or more in FAA (formalin/glacial acetic acid/ 50% ethanol (1:1:18, by vol.).

After fixation the specimens were brought down to water through 70% ethanol and hydrolyzed in 3.5 M HCl (37°C) for 20 min. Nuclei were optimally stained with this hydrolysis schedule (Fand, 1970) and hence it was used throughout the study (Fig. 1). After hydrolysis the specimens were rinsed in water and stained 3.5 h in Schiff reagent (Leuchtenberger, 1958). Pararosaniline was used as the stain of choice because 1) nuclei stained vividly and were very clearly resolved with fluorescence microscopy 2) unlike other fluorochromes it quenched very slowly upon excitation and 3) it fluoresced in green light in proportion to DNA content (Bosshard, 1964; Ruch, 1966; Böhm & Sprenger, 1968).

To prepare the nuclear stain 0.5 g pararosaniline hydrochloride (Harleco basic fuchsin, lot #60801, certified by the Biological Stain Commission) was dissolved in 100 ml of boiling water, cooled to 50°C and filtered. To the filtrate were added 10 ml of 1 M HCl and 1.0 g of $K_2S_2O_5$. The stain was stored in the dark for 18 h; subsequently, 0.25 g of decolorizing carbon was added, the material shaken 1 min and then rapidly filtered. Stained specimens were differentiated 10 min in each of three sulfite rinses of deionized water/10% aqueous potassium meta-bisulfite/1 M HCl (18:1:1, by vol.), dehydrated in 50%, 70%, 95%, and 100% ethanol, cleared in ethanol/xylene (1:1, by vol.), three changes of xylene, and mounted in Entellan, a nonfluorescent resin.

Microfluorometry with epifluorescence was used to estimate nuclear DNA because it is much more sensitive than absorbance microphotometry, light scattering is less troublesome, and the light quanta emitted by specimens are uniformly measured by the photomultiplier, even when DNA in the nucleus is unevenly distributed (Bosshard, 1964; Ruch, 1966). Also, the laborious calculations associated with the two-wave method (Patau, 1952) required to overcome distributional errors were avoided.

A Dialux 20 microscope equipped with a Leitz MPV photometer, fixed measuring diaphragms, a 1X Ploemopak vertical illuminator, and a 100 W Hg vapor lamp were used to measure fluorescence intensities of individual nuclei. The lamp routinely was allowed to burn 15-20 min before fluorescence intensities were read. A Leitz MPV control panel interfaced with a Hewlett-Packard 86 B computer was used to record and

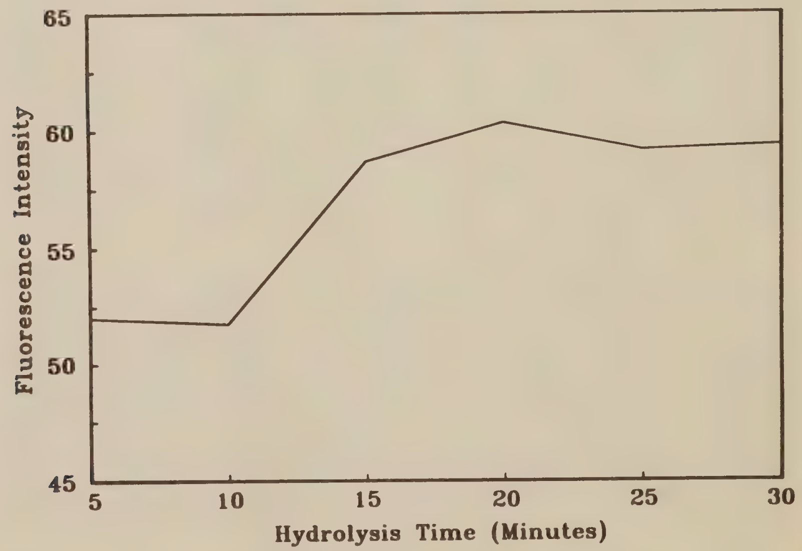

Fig. 1. *Saccharomyces cerevisiae*. The relationship between fluorescence of haploid nuclei stained with pararosaniline-Schiff and hydrolysis periods of from 5 to 30 min in 3.5 M HCl at 37°C. Each point is the mean of 30 fluorescence measurements.

statistically analyze fluorescence data. An A filter block (excitation range 340-380 nm, barrier filter 430 nm) and a uranium glass slide (Schotts-Mainz GG-17) were used to standardize the panel. With the iris in the illuminator open, and a fixed 0.2 mm circular measuring aperture in place, a X100 oil immersion objective (N.A.1.32) was focused on the slide for maximum fluorescence and the potentiometer adjusted to give a digital display reading of 99.9-100. During standardization the preselector was set for minimum sensitivity (X1), the measured-value integration for continuous measurement and display (nx), and the high-tension amplification adjusted to 700 V. To isolate incident light and record fluorescence intensities of nuclei an N2 filter block (excitation range 530-560 nm, barrier filter 580 nm) was used, the sensitivity range increased to X100, and the measured-value integration adjusted for readings averaging 1.0 sec (T2).

To standardize exposure of the stained nuclei to the excitation source microscopic fields were selected in which the nuclei were separated by distances several times their diam. Using the X100 objective with the illuminator iris closed provided a field 22.0 μm in diam. A fixed aperture 0.2 mm in diam was used to isolate single nuclei. The aperture provided a field 2.0 μm in diam or slightly larger than the nuclei. Fluorescence intensities were recorded after each nucleus was exposed to 1 min of excitation because this much time was required for the intensity/time curve to stabilize. After each measurement a background reading of the accompanying cytoplasm was subtracted from the fluorescence intensity of each nucleus. Since other nuclei in the field unavoidably were exposed to excitation, only one intensity reading was taken per field.

Specimens consisting of 6 to 10 species were simultaneously processed with specimens of the internal standard in each series of experiments. In each experiment the fluorescence intensities of 30 nuclei of the standard were averaged, the means ranging from 55.7 to 61.0 fluorescence units, the standard errors of the means from 2.2 to 3.1. To estimate the average amount of DNA of each species the fluorescence intensities of 30 to 60 nuclei were likewise averaged, the means multiplied by 1.5×10^{10} daltons, and the product divided by the mean fluorescence of the corresponding standard.

Diploid values for the smut fungi were based on measurements of the single nucleus contained in each teliospore, haploid values mostly on uninucleate sporidia. Haploid nuclei of *N. tetrasperma* were measured in immature ascospores at the 2- and 4-nucleate stage. Lacking melanin at this time, the measurements were made without frustration. Because the nuclei in ascospores were often closely spaced, only one nucleus per ascospore was measured. Diploid values were measured in young developing asci, all of which contained one nucleus. Haploid values for *N. crassa* were based on measurements of pre-S microconidia and vegetative mycelium in which cells were dividing.

RESULTS AND DISCUSSION

The average amounts of haploid DNA for the various species were plotted against fluorescence intensity. A linear relationship was shown, (Fig. 2) the slope of the line was 5.137, and r = 0.982. The average amounts for most species fell between 13.5 X 10^9 and 30.0 X 10^9 daltons. No general correlation of genome size and generic affinities was suggested, although nine species of *Tilletia* and *Schroeteria delastrina* contained the most DNA. The average haploid DNA content of each species and other data are summarized in Table 1.

The average amounts of nuclear DNA, the range of values, and the C-values for haploid and diploid nuclei of the nine species tested were summarized (Table 2). Since all materials were unarrested the values of haploid nuclei ranged from 1 to 2 C, those of diploid nuclei from 2 to 4 C. The values

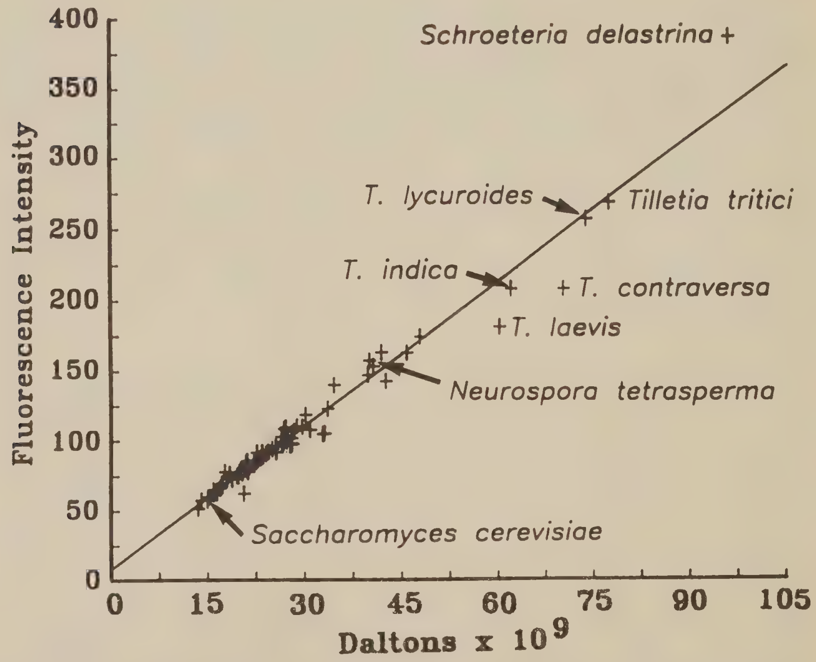

Fig. 2. Proportionality between fluorescence and DNA content in haploid nuclei of 70 species of smut fungi and *Neurospora tetrasperma*. Each point is the mean of 20-38 fluorescence measurements. The slope of the line is 5.137 and r=0.982. [Genome size assigned the internal standard (*Saccharomyces cerevisiae*) was 1.5 x 10^{10} daltons of DNA]. See Table 1 for statistical data.

are graphically shown in Figure 3. Especially noteworthy were values of young asci of *N. tetrasperma* because the single nuclei contained therein showed intergrading values which ranged from 51.9-129.6 X 10^9 daltons (Fig. 4). The few

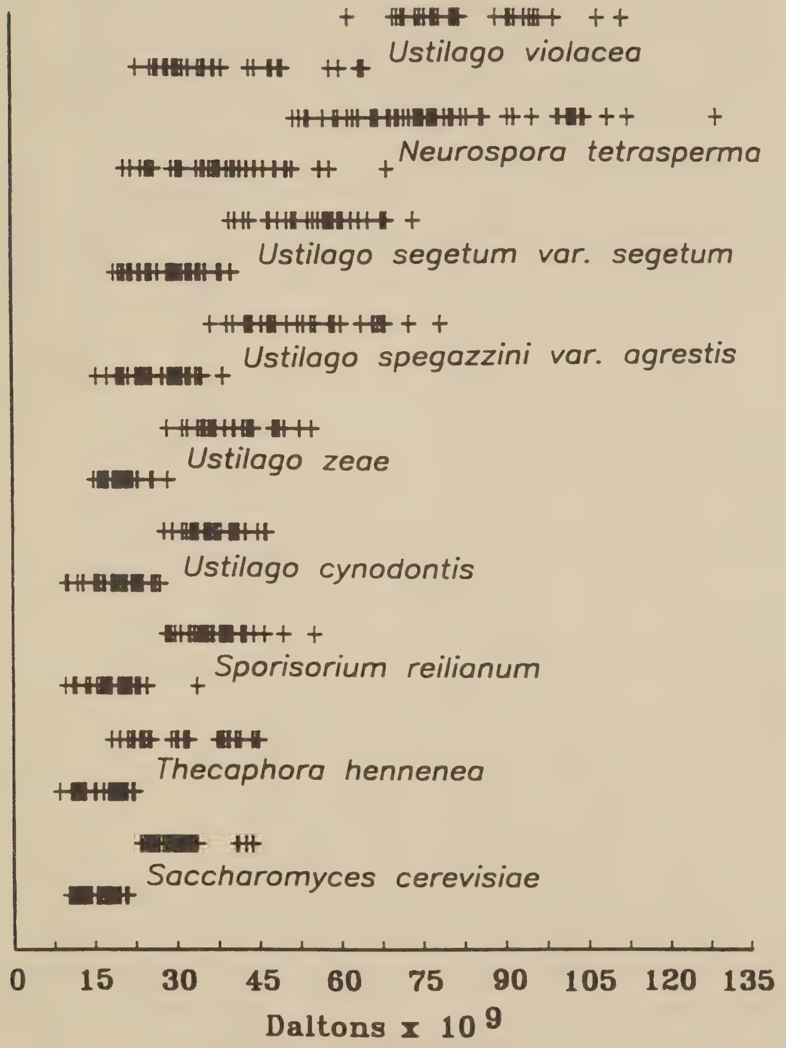

Fig. 3. Ranges of nuclear DNA in haplo- and diplophases of seven species of smut fungi, and in *Neurospora tetrasperma* and *Saccharomyces cerevisiae*. (Average amounts and 1 and 2 C values are summarized in Table 2.)

nuclei in primary asci which gave values around 4 C (Fig. 4) might have resulted from replication in the croziers, although the data mostly suggested that the diploid nuclei were in varying stages of post-karyogamy synthesis. This contrasts what has been described in *Neottiella rutilans* (Fr.) Dennis by Rossen & Westergaard (1966), namely, that meiotic chromosome replication is completed *before* karyogamy in the croziers, i.e. before primary asci form. The diploid nuclei of teliospores, like those of asci, were likewise in varying stages of post-karyogamy replication, as evidenced by values which ranged in general from 2 C to 4 C (Table 2).

The haploid genome of *N. crassa* has been variously estimated over the years and hence merits brief discussion. From chemical extractions Horowitz & Macleod (1960) estimated that microconidia averaged 27.7 X 10^9 daltons of DNA. By renaturation kinetics Krumlauf & Marzluf (1980) calculated that haploid nuclei of mycelia contained about 2.7 x 10^7 base

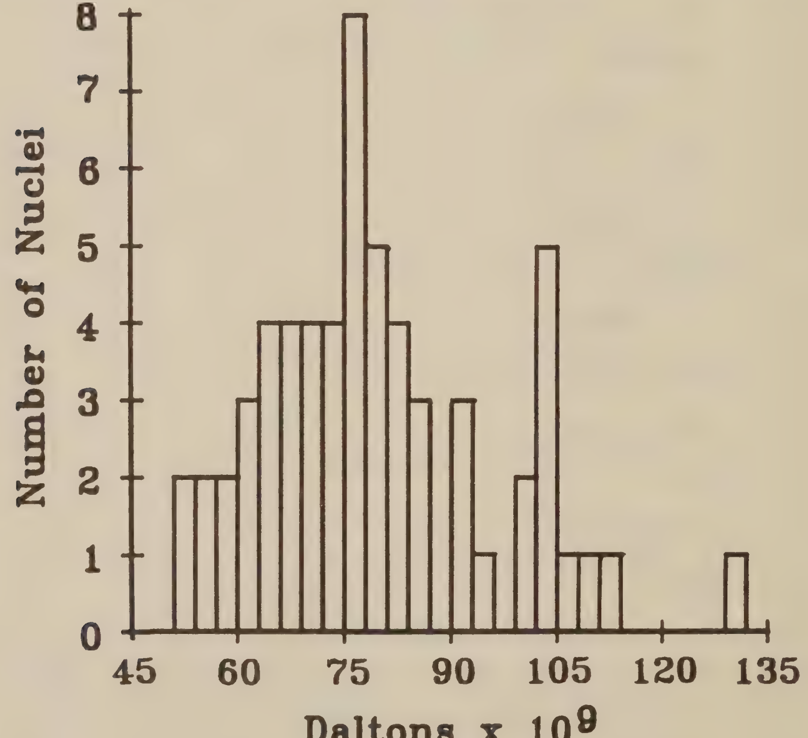

Fig. 4. *Neurospora tetrasperma*. Diploid DNA values in young asci, all with one nucleus. Mean = 79.3 x 10^9 daltons; s.e.m. = 2.16; the range 51.9-129.6 x 10^9 daltons; n = 60.

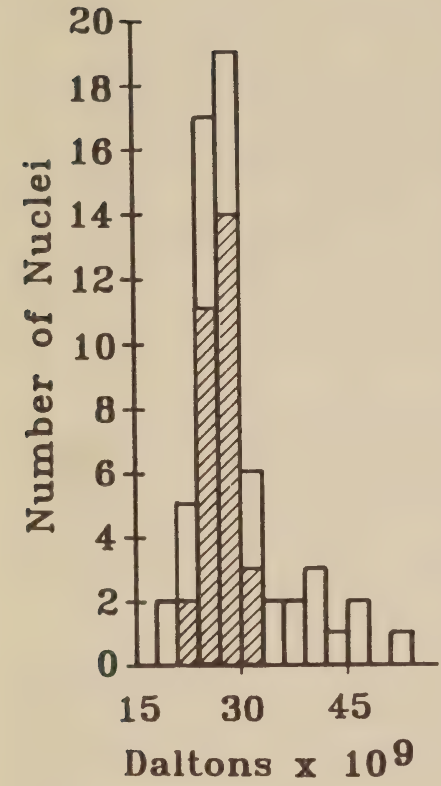

Fig. 5. *Neurospora crassa*. Haploid DNA values in microconidia (hatched bars). Mean = 27.0 x 10^9 daltons; s.e.m. = 0.39; the range 23.9-31.6 x 10^9 daltons; n=30. Mycelia (open bars). Mean = 31.6 x 10^9 daltons; s.e.m. = 1.54; the range 20.7-51.0 x 10^9 daltons; n=30. Chromosomal DNA in microconidia mostly unreplicated, some in mycelia replicated and hence somewhat greater.

pairs. Microconidia of the peach/fluffy strain we used were 99% uninucleate and averaged 27.0 X 10^9 daltons per nucleus. Mycelia, however, averaged more DNA than microconidia, apparently because some nuclei were pre-S and some post-S. Since *N. crassa* microconidia mostly were unreplicated (Fig. 5), the mean and 1 C values were virtually the same. If the estimate of Krumlauf & Marzluf (op. cit.) is a 1 C value for non-dividing cultures, multiplying it by 1.5 would yield also a theoretical mean of about 27.0 X 10^9 daltons.

Using an alternating-field gel electrophoretic system which employs contour-clamped homogeneous electric fields (CHEF), Orbach, Volbrath, Davis & Yanofsky (1988) estimated the molecular karyotype of *N. crassa* to be around 31.3 x 10^9 daltons. This exceeds the estimates indicated above but equals the amount indicated herein for mycelium (Table 1; Fig. 5).

Estimates of nuclear DNA should be included in descriptions of fungi when possible, either in lieu of the chromosome number or in addition to it. Such information could prove to be very useful in taxonomic studies of fungi, especially among fungi with a dearth of definitive characteristics. Durán and Fischer (1961), for example, concluded that *Tilletia horrida* Tak. on rice was a synonym of *Tilletia barclayana* (Bref.) Sacc. which parasitizes range grasses. However, this study showed that *T. horrida* contains 24% more DNA than *T. barclayana* hence the two probably are distinct species. Furthermore, the protocol for the quantification of nuclear DNA as described herein was simple, inexpensive, and consistently yielded reproducible results.

The amount of DNA ascribed to *S. cerevisiae* for purposes of estimating the DNA content of the fungi included in this study deserves additional mention because it relates to the veracity of the data presented herein. The decision to use 1.5×10^{10} daltons in the calculations stemmed from a number of sophisticated researches, namely, those of Bicknell et al. (1970), Lauer et al. (1977), and Mortimer et al. (1985), all of which provided estimates of the haploid genome which hovered around 1.0×10^{10} daltons. Since this figure probably closely approximated the 1 C value of haploid nuclei, the estimates of DNA presented here were considered near absolute amounts for dividing cells, exclusive of mitochondrial DNA.

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We thank Professor David D. Perkins, Stanford University for his critical and unstinting review of the manuscript and for the suggestions he offered to improve it. We are likewise indebted to him for the peach/fluffy microconidial strain of *Neurospora crassa* which proved to be an invaluable part of this study. We also thank Professor Jack D. Rogers for the culture of *Neurospora tetrasperma*. Finally, we are most grateful to Jane M. Lawford for her unflagging patience in typing several versions of the manuscript.

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Table 1. Estimates of nuclear DNA in haploid nuclei of 72 species of fungi.

	daltons x 10^9		
Species	mean	range	s.e.m.
Ustilago succisae	13.5[1/]	9.1-21.6	0.61(30)
Tolyposporium penicillariae	13.9	5.5-36.1	1.26(30)
Sphacelotheca hydropiperis	15.0	7.9-26.7	0.76(30)
Sphacelotheca cruenta	15.3	9.7-22.6	0.70(31)
Thecaphora hennenea[2/]	15.9	8.5-22.3	0.70(31)
Sporisorium anthistirae	15.9	10.2-24.9	0.69(30)
Ustilago betonicae	16.3	8.5-24.6	0.69(30)
Tolyposporium bullatum	16.9	9.6-23.4	0.79(30)
Sporisorium puellare	16.9	9.0-28.6	0.79(30)
Urocystis colchici	17.1	11.5-24.1	0.58(30)
Cintractia taubertiana	17.1	9.7-31.6	1.14(30)
Ustilago convertere-sexualis	17.2	10.5-29.7	0.99(30)
Sorosporium consanguineum	17.7	8.7-24.7	0.88(30)
Sorosporium penuriasorus	18.0	8.4-32.4	1.08(30)
Sporisorium reilianum	18.3	9.6-33.4	0.88(30)
Ustilago cynodontis	18.7	9.7-26.8	0.84(30)
Ustilago zeae	19.5	14.8-28.3	0.57(30)
Ustilago scitaminea	19.8	11.5-27.6	1.00(30)
Ustilago aschersoniana	19.9	13.8-28.2	0.69(30)
Ustilago spermophora	20.4	12.1-34.9	1.18(30)
Ustilago tricophora	20.5	11.2-30.9	1.02(30)
Ustilago buchloës	20.7	15.4-29.1	0.61(30)
Sporisorium rhynchelytri	20.8	11.2-28.6	0.79(30)
Sporisorium sorghi	21.0	11.2-33.9	0.99(30)
Ustilago ixophori	21.1	12.1-28.8	0.88(30)
Tilletia barclayana	21.1	13.8-28.8	0.96(30)
Sphacelotheca diplospora	21.4	12.7-32.5	1.03(30)
Sorosporium caledonicum	22.2	11.8-36.7	1.21(30)
Sphacelotheca pamparum	22.5	9.6-34.8	1.18(30)
Sorosporium cenchri	22.6	12.1-33.1	1.29(30)
Ustilago bethelii	22.8	14.1-31.5	0.99(30)
Sphacelotheca monilifera	23.2	14.2-34.6	1.08(30)
Ustilago opiziicola	23.4	12.1-32.8	1.24(30)
Sphacelotheca nealii	23.5	13.6-38.5	1.35(30)
Sphacelotheca andropogonis-hirtifolii	24.0	16.0-34.6	0.79(30)
Ustilago neglecta	24.3	13.3-31.8	0.64(30)
Sorosporium confusum	24.4	13.2-39.3	1.29(30)
Tilletia tuberculata	24.9	17.7-40.3	1.23(30)
Tilletia trachypogonis	25.5	14.1-32.4	1.29(20)
Tilletia rugispora	25.5	17.1-29.5	0.45(30)
Tolyposporium junci	26.4	14.2-33.0	0.88(30)
Sorosporium mixtum	26.4	13.3-35.1	1.26(30)

Ustilago elegans	26.7	19.0-36.6	0.88(30)
Ustilago tricuspidis	26.7	16.0-41.8	1.32(30)
Ustilago spegazzini var. *agrestis*[1]	27.0	15.4-38.4	1.02(30)
Ustilago minor	27.3	15.0-50.2	1.84(30)
Ustilago enneapogonis	27.7	15.1-47.8	1.42(30)
Tilletia horrida	27.9	18.9-46.9	1.68(30)
Melanopsichium pennsylvanicum	27.9	16.5-47.4	1.38(30)
Ustilago bullata	28.3	18.6-37.6	0.88(30)
Ustilago segetum var. *segetum*	28.6	18.7-40.0	1.08(35)
Ustilago aegopogonis	29.5	18.1-44.7	1.56(30)
Ustilago segetum var. *avenae*	30.1	17.2-49.6	1.86(30)
Tilletia narasimhanii	31.0	17.2-45.9	1.24(30)
Neurospora crassa	31.6	20.7-51.0	1.54(30)
Tilletia obscura-reticulata	32.7	25.0-54.9	1.78(30)
Tilletia boutelouae	33.0	24.4-43.2	0.99(30)
Tilletia buchloeana	33.6	25.0-43.0	0.79(30)
Tilletia muhlenbergiae	34.5	18.0-46.5	1.60(30)
Tilletia narayanaraoana	39.7	23.5-54.1	1.74(30)
Neurospora tetrasperma[3]	39.9	20.5-68.7	1.77(38)
Ustilago violacea	40.5	23.2-64.8	2.28(30)
Sorosporium saponariae	41.8	22.5-59.1	2.22(30)
Tilletia durangensis	42.6	30.9-73.5	1.77(30)
Tilletia aegopogonis	45.7	25.6-63.6	1.98(30)
Tilletia brunkii	47.8	25.6-79.3	2.65(30)
Tilletia laevis	60.1	35.5-80.1	2.28(30)
Tilletia indica	61.9	41.2-81.6	1.98(30)
Tilletia contraversa	70.2	38.4-99.9	3.16(30)
Tilletia lycuroides	73.6	27.0-127.8	4.93(30)
Tilletia tritici	77.2	40.5-117.7	4.48(30)
Schroeteria delastrina	95.8	43.9-164.8	6.10(30)

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[1] The means shown are 1.5 times the 1 C value and are relative to nuclear measurements in dividing cultures of the standard, *Saccharomyces cerevisiae*, in which 1 C = 1.0 X 10^{10} daltons of DNA, and the mean for dividing cultures therefore = 1.5 X 10^{10} daltons. Data plotted in Figure 2.

[2] Measurements for *Thecaphora hennenea, Urocystis colchici, Ustilago spegazzini* var. *agrestis*, and *Neurospora crassa* from mycelial nuclei; all other measurements of smut fungi from secondary sporidia.

[3] From 2- and 4-nucleate ascospores.

Table 2. Average amounts of nuclear DNA estimated for haploid and diploid nuclei of nine fungi and their corresponding C values.[1]

	daltons X 10^9							
	n nuclei				2n nuclei			
Species	mean	s.e.m.	range	1C value	mean	s.e.m.	range	2C value
Ustilago violacea	40.5	±2.28(30)	23.2-64.8	27.0	83.8	±2.14(30)	61.9-112.0	55.8
Neurospora tetrasperma[2]	39.9	±1.77(38)	20.5-68.7	26.5	79.3	±2.16(60)	51.9-129.6	52.9
Ustilago segetum var. *segetum*	28.6	±1.08(35)	18.7-40.0	19.0	56.1	±1.63(30)	40.0-73.6	37.3
Ustilago spegazzini var. *agrestis*[3]	27.0	±1.02(30)	15.4-38.4	18.0	54.1	±1.99(30)	36.3-78.3	36.0
Ustilago zeae	19.5	±0.57(30)	14.8-28.3	12.9	41.1	±1.18(30)	28.2-54.6	27.3
Ustilago cynodontis	18.7	±0.84(30)	9.7-26.8	12.4	36.7	±0.91(30)	27.7-46.2	24.4
Sporisorium reilianum	18.3	±0.88(30)	9.6-33.4	12.1	37.5	±1.14(30)	28.0-55.0	24.9
Thecaphora hennenea	15.9	±0.70(31)	8.5-22.3	10.5	31.0	±1.48(31)	18.1-45.0	20.7
Saccharomyces cerevisiae[4]	15.0	±0.57(30)	10.3-21.0	10.0	30.1	±0.99(30)	23.5-43.8	20.1

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[1] See Swift (1950) for C-value terminology.

[2] Haploid nuclei measured in ascospores at the 2- and 4-nucleate stage. Diploid nuclei measured in developing asci with one nucleus. Measurements based on ATCC #38097.

3/ Haploid nuclei of the smut fungi measured in uninucleate sporidia, diploid nuclei in uninucleate teliospores. (In *Ustilago spegazzini* var. *agrestis* and *Thecaphora hennenea* haploid nuclei measured in young thalli formed by germinating teliospores.)

4/ Haploid measurements based on C. C. Lindegren's 2333 haploid mating type alpha strain (ATCC #10275). For diploid measurements ATCC #26109 was used (E. Cabib x 2180 & R. K. Mortimer, NCYC 826).

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MELIOLACEOUS FUNGI FROM THE STATE OF KERALA, INDIA I.

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SUMMARY

This paper reports in part the results of a survey undertaken during 1981-1984 of the meliolaceous fungi found in the Idukki Hydroelectric Project Area in the State of Kerala, India. Two hundred fifty eight collections were made, resulting in the identification of 103 species and infra- specific taxa. Of these, 32 are undescribed species, and 13 have been determined to be new varieties. These fungi will be described in subsequent papers. Twenty-seven taxa were recorded from India for the first time. The taxa were distributed in five genera, as follows: Amazonia (4), Armatella (2), Asteridiella (9), Irenopsis (4), and Meliola (84).

Species belonging to genera other than Meliola are treated in this paper, and include four species of Amazonia, with three new species A. acronychiae, A. actinodaphnis and A. syzygii; two species of Armatella, nine species of Asteridiella, including the four new species A. clerodendricola, A. crotonis, A. macarangicola, and A. turpiniicola; four species of Irenopis, including the new species I. eriolaenae, and a new variety I. leeae Hansford var. indica.

Keywords: Meliolaceae, Amazonia, Armatella, Asteridiella, Irenopsis, India, Kerala, black mildews.

The Meliolaceae (Order Meliolales), commonly known as the 'black mildews' or 'dark mildews', are epiphyllous parasites on a broad range of host plants. As a group, they show many parallels with the 'powdery mildews' (Order Erysiphales) (Alexopoulos & Mims, 1979) and have been considered by some authors (Wellman, 1972) to be a tropical counterpart of that group. They are sometimes erroneously referred to as "sooty moulds", which are saprobic fungi associated with scale insects or honey dew producers and which are placed in another order of fungi (Stevens, 1931; Hughes, 1976). In contrast to the sooty moulds, the black mildews are parasites, penetrating their hosts by means of haustoria that arise from the characteristic superficial hyphopodiate mycelium. The production of the bulbous haustoria from the lower surface of the head cells of the capitate hyphopodia has been schematically illustrated by Doidge (1921) Roger (1953) and Luttrell (1989). The black mildews are most abundant in the tropics, although some species occur in temperate regions.

As with Erysiphales and the Uredinales, the Meliolales show a high level of host specialization, making it essential to know the host species before any attempt is made to identify these fungi to the species level. The probability of accurately identifying these fungi to the species level or of recognizing a new taxon without first identifying the host are remote. Although attempts have been made to culture these fungi, both in the laboratory and on host plants (Bal, 1919; Hansford, 1961; Thite, 1975; Goos, 1978), no one has yet succeeded in doing so.

Hansford's (1961) monumental monograph of the group gives an account of 1814 taxa, known from throughout the world. About 100 taxa, including homonyms and synonyms, have been reported from India (Bilgrami et. al., 1979, 1981; Hosagoudar, 1985).

To learn more about the occurrence of the Meliolaceae in India, a survey was made in the region of the Idukki Hydroelectric Project Area in Kerala. This study was carried out during the period 1981-84, when twenty well-planned collecting trips, covering all seasons, were conducted. These surveys resulted in 258 collections. There are no prior collection records for this region, and several of the collections are new records for India.

THE STUDY AREA

Idukki, the largest hilly district in Kerala State, is located in the Western Ghats, between 9° 15' and 10° 21' of north latitude and 76° 37' and 77° 25' of east longitude. The district extends 115 km north to south and 67 km east to west (Fig. 1). The important feature of this district is the Idukki Hydroelectric Project. The reservoir combines the courses of the Cheruthoni and Periyar rivers and is spread over an area of 59.8 sq km. The catchment area of the reservoir is 649.3 sq km and is situated at an altitude of 695 m.

The forest area bordering the reservoir, an area estimated to contain 57,312 hectares including the reservoir and the catchment area, was chosen for study. (see Fig. 1). Climatological data for the area are summarized in Fig. 2.

The following types of forests, as classified by Chandrasekharan (1962), Champion and Seth (1962) and Mohanan (1985), are found in the study area: (1) West Coast Tropical Evergreen Forests, (2) West Coast Semi-Evergreen Forests, (3) Southern Moist Mixed Deciduous Forests, and (4) South Indian Subtropical Hill Savanna (grassland with exposed rocks and scattered trees). The understory of the evergreen forests has been cleared and cash crops such as cardamom, coffee, and ginger are now grown.

METHODS AND MATERIALS

Identification of the host plant is an essential step in the identification of these fungi; hence, it was necessary to collect specimens of the host, preferably with reproductive parts, when making collections of the fungi. Each specimen collected was assigned a collection number, and data regarding pathogenicity, nature of the colonies, nearby infected host plants and other relevant information was recorded. Following collection, the leaf material was dried between blotters, changed daily for several days (Jain and Rao, 1977). Host identity was confirmed with the help of experts and through comparison with specimens deposited in the Madras Herbarium, Coimbatore, (M.H.). For rapid temporary mounts, cellophane tape worked well. For permanent mounts, use of clear nail polish, which is both cheap and readily available, was preferred. With this method, a drop of the nail polish was applied to the fungal colonies, spread carefully with the tip of a fine brush so as not to disturb the colonies, and allowed to dry in a dust free chamber for about half an hour. A "flip" was formed, with the fungal colonies firmly embedded in it. This was easily eased off the leaf with the help of a razor blade or scalpel. A drop of mounting medium, such as Canada balsam or D.P.X. was spread on a clean slide, and the flip carefully placed upon it so as to avoid air bubbles. Two more drops of the mounting medium were placed over the flip, and a clean cover glass gently applied. The slides were allowed to dry for 2 to 3 days in a dust free chamber, after which the excess mounting medium was removed.

In some fungi, septa may not be visible because of the heavy pigmentation. In such cases, fungal material was scraped from the leaf and mounted in 10% KOH solution. After 30 minutes, the KOH was removed and replaced with clear lacto-phenol (prepared according to Rangaswamy, 1975). Both KOH and lacto-phenol are good clearing agents, making the septa visible for study. Camera lucida drawings were made of all specimens.

TAXONOMIC REVIEW

Meliola and its associated genera were formerly considered under the tribe Meliolineae (Stevens, 1927, 1928; Hansford, 1961). Martin (1941) proposed the family Meliolaceae in the Order Meliolales; the description of the family was emended and validated by Hansford (1946). Alexopoulos and Mims (1979) followed this arrangement. Yarwood (1973), however, considered all of the genera of the family Meliolaceae under the Perisporaceae of the Order Erysiphales. Müller and von Arx (1973) considered the Meliolaceae under the *unitunicatae* of the Order Meliolales. Hawksworth *et al*. (1983) and Eriksson (1982) placed the Meliolaceae under a broadly conceived Order Dothideales. Hawksworth and Eriksson, in Eriksson and Hawksworth (1986), emended the description of the Order Meliolales proposed by Gaumann (1964), treating it under the *bitunicatae*, and compared the group with the Microthyriales. Luttrell (1989) concluded that the Meliolales belong in the Pyrenomycetes (in the narrow sense) and should not be placed with the Loculoascomycetes, thus essentially agreeing with Müller and von Arx (1973).

For many years, *Meliola amphitricha* Fries was considered to be the type species of the genus. Arnaud (1918) was the first to question its validity, and subsequent study has shown it to be a *nomen confusum*. The situation was reviewed by Toro (1952) who resolved the problem by selecting *M. trichostroma* (Fr.) Toro as the lectotype species. Hansford (1961) accepted Toro's views and segregated from the "catch-all" species, *M. amphitricha* Fr., more than 100 species, relegating the name *M. amphitricha* to his list of Species Excludendae, with the comment: "that ephithet is discarded".

The number of genera assigned to the family Meliolaceae varies from 5 to 50, depending on the limits established for the family. Stevens (1927, 1928) considered seven genera; Hansford (1961) gave an account of five genera; Ainsworth (1971) recognized about fifty genera; Müller and von Arx (1973) included seven genera, while Eriksson and Hawksworth (1986) included twenty-two genera, three of which were doubtful. To keep the group homogeneous, we are following Müller and von Arx (1973) in treating six genera, namely: *Amazonia*, *Appendiculella*, *Armatella*, *Asteridiella*, *Irenopsis* and *Meliola*. The saprobic, rhizophyllous, monotypic genus *Diporotheca* Gordon and Shaw is excluded.

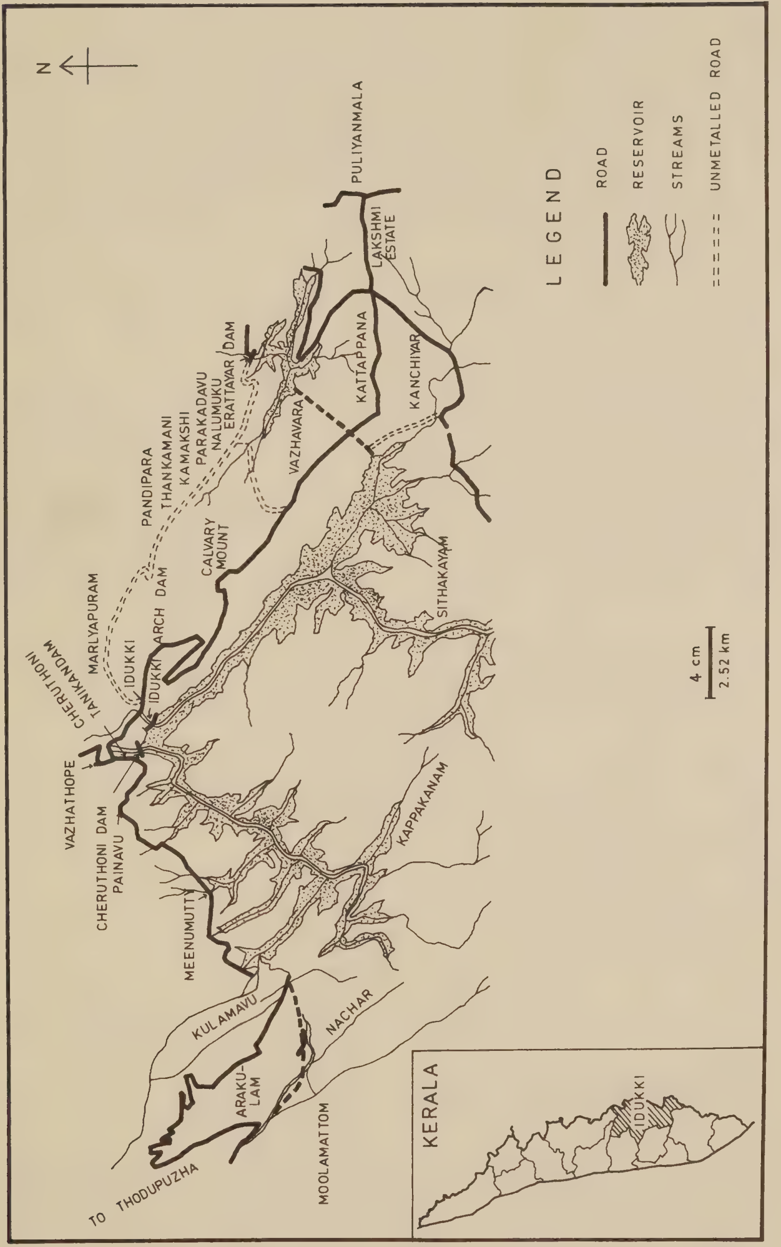

N
LEGEND
ROAD
RESERVOIR
STREAMS
UNMETALLED ROAD
PULIYANMALA
LAKSHMI ESTATE
KATTAPPANA
KANCHIYAR
ERATTAYAR DAM
NALUMUKU
PARAKADAVU
KAMAKSHI
THANKAMANI
PANDIPARA
VAZHAVARA
CALVARY MOUNT
SITHAKAYAM
MARLYAPURAM
IDUKKI ARCH DAM
IDUKKI
CHERUTHONI
TANIKKANDAM
VAZHATHOPE
CHERUTHONI DAM
PAINAVU
MEENUMUTTY
KAPPAKANAM
KULAMAVU
NACHAR
ARAKU-LAM
MOOLAMATTOM
TO THODUPUZHA
KERALA
IDUKKI
4 cm
2.52 km

Fig. 1. A map of the Idukki Hydroelectric project area.

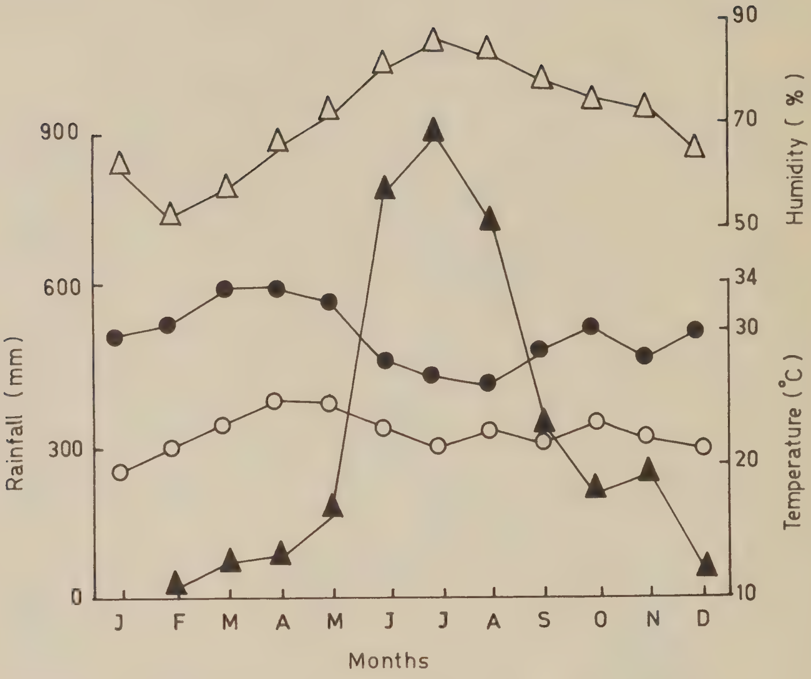


Fig. 2. Climatological data for the Idukki Project Area, based on the average of five years (1978-1982).

● Maximum temperature

○ Minimum temperature

▲ Rainfall

△ Humidity

We are following Hansford (1961) and Luttrell (1989) in using the term mucronate hyphopodia for the phialide-like branches found on the mycelium of many members of the Meliolaceae. Hughes (1981), following the examination of several species, concluded that these structures do indeed function as phialides, but Luttrell (1989) did not find this to be the case in *Meliola floridensis* Hansf. Until further evidence is brought forth, it seems advisable to continue use of the established terminology.

ORDER MELIOLALES: with a single family.

FAMILY MELIOLACEAE Martin ex Hansford. CMI Paper 15:23. 1946.

Foliicolous ectoparasites; *mycelium* superficial, brown, septate, branched, hyphopodiate; thin, penetration hyphae arising from the apical (head) cells of the capitate hyphopodia penetrating the underlying host epidermis and forming haustoria within the epidermal cells; mucronate hyphopodia often present, mycelial setae present or absent; *ascomata* superficial, globose, dark, with parenchymatous wall of one or more layers, usually without ostioles, setae and appendages often present on ascomatal wall; *asci* borne in hymenium, 2 to 8 spored, evanescent; *ascospores* 1, 3, or, 4 septate, brown at maturity.

KEY TO THE GENERA OF THE MELIOLACEAE: (*Sensu* Müller & von Arx, 1973)

1. Ascospores 0-1 septate . . . . . *Armatella*
1. Ascospores 3-4 septate 2
    2. Mycelial setae present .. . .*Meliola*
    2. Mycelial setae absent 3
3. Setae present on ascomata . . . .*Irenopsis*
3. Setae not present on ascomata 4
    4. Appendages present on ascomata . . . . *Appendiculella*
    4. Appendages not found on ascomata . . 5
5. Ascomata below a shield of radiating mycelium . . . . *Amazonia*
5. Ascomata lacking shield . . .*Asteridiella*

Description of the genera

1. *Amazonia* Theissen, Ann. Mycol. 11:499. 1913.
    = *Actinodothis* Sydow & Sydow, Philipp. J. Sci. 9:174. 1914.
    = *Meliolaster* Doidge, Trans. Roy. Soc. South Africa 8:123. 1920. (non *Meliolaster* Hoehnel, 1918)

Mycelium superficial, brown, septate, branched, hyphopodiate. *Ascomata* globose, perithecioid, in a shield of radiating mycelium. *Asci* 2-4 spored, evanescent. *Ascospores* 3 or 4 septate, brown.

Type species: *A. psychotriae* (P. Henn.) Theissen, based on *Meliola asterinoides* Winter var. *psychotriae* P. Henn.

2. *Appendiculella* Hoehnel, Sitzb. K. Akad. Wiss. Wien, Math. - naturw. Kl. 128:556. 1919.
= *Irene* Theiss. & Sydow *sensu* Stevens, Ann. Mycol. 25:420. 1927. (*non* *Irene* Theissen & Sydow, 1917).

Mycelium superficial, brown, septate, branched, hyphopodiate, without setae. *Ascomata* superficial, globose, perithecioid, bearing larviform appendages, setae lacking. *Asci* 2 - 4 spored, evanescent. *Ascospores* 3-4 septate, brown.

Type species: *A. calostroma* (Desm.) Hoehnel, based on *Sphaeria calostroma* Desm.

3. *Armatella* Theissen & Sydow, Ann. Mycol. 13:235. 1915.
= *Artallendea* Bat. & Maia, Atas Inst. Micol., Univ. Recife 1:222. 1960.

Mycelium superficial, brown, septate, branched, hyphopodiate, lacking setae. *Ascomata* superficial, globose, lacking appendages and/or setae. *Asci* 4-8 spored, evanescent. *Ascospores* initially non-septate and hyaline, becoming brown and 1 septate at maturity. On germination, the upper cell enlarges to from a capitate hyphopodium; the other empties and collapses.

Type species: *A. litseae* (P. Henn.) Theiss. & Sydow.

4. *Asteridiella* McAlpine, Proc. Linn. Soc. New South Wales, 1897, p. 38.
= *Irene* Theiss. & Sydow, Ann. Mycol. 15:194. 1917.
=*Irenina* Stevens, Ann. Mycol. 25:411. 1927.

Mycelium superficial, brown, septate, branched, hyphopodiate, lacking setae. *Ascomata* superficial, globose, lacking appendages and/or setae, cells protruding. *Asci* 2-4 spored, evanescent. *Ascospores* 3-4 septate, brown.

Type species: *A. solani* McAlpine.

5. *Irenopsis* Stevens, Ann. Mycol. 25:411. 1927.

Mycelium superficial, brown, septate, branched, hyphopodiate, setose. *Ascomata* superficial, globose, perithecioid. *Asci* 2-4 spored, evanescent. *Ascospores* 3-4 septate, brown.

Type species: *I. tortuosa* (Winter) Stevens, based on *Meliola tortuosa* Winter.

6. *Meliola* Fries emended Bornet, Ann. Sci. Nat. III, 16:267. 1851.
≡*Meliola* Fries, Syst. Orb. Veg. 1825, p. 111.
=*Amphitrichum* Nees ex Spreng, Pl. Crypt. Trop. 1820. p. 46, *pro parte*

=*Sphaeria* Fries, Syst. Myc. 2:513. 1823. *pro parte*.
=*Myxothecium* Kunze in Fries, Syst. Mycol. 3:232. 1829.
=*Couturea* Cast. in Fries, Summa Veg. Sand. 1846, p. 407.
=*Asteridium* Sacc., Syll. Fung. 1:49. 1882.

Mycelium superficial, brown, septate, branched, hyphopodiate, setose. *Ascomata* superficial, globose, perithecioid, lacking setae and/or appendages. *Asci* 2-4 spored, evanescent. *Ascospores* 3-4 septate, brown.

Lectotype species: *M*. *trichostroma* (Kunze) Toro, based on *Sphaeria*? *trichostroma* Kunze.

RESULTS

Meliolaceous fungi collected and identified in this survey include 103 taxa, distributed among five genera, as follows: *Amazonia* (4), *Armatella* (2), *Asteridiella* (9), *Irenopsis* (4), and *Meliola* (84). Of these taxa, 32 are new species, 13 are new varieties, and 27 taxa are reported from India for the first time (Hosagoudar, 1987). Formal descriptions of new taxa will be presented in subsequent papers. The highest incidence of meliolaceous fungi occurred at the end of the rainy season.

Twenty-four of the host plants are endemic to the Western Ghats (Ahmedullah & Nayar, 1987). Of these, *Apodytes* *benthamiana* (Icacinaceae), *Atylosia* *lineata* (Papilionaceae), *Cinnamomum* *malabatrum* (Lauraceae), *Ixora* *elongata* (Rubiaceae), *Litsea* *coriacea*, *L*. *stocksii* var. *glabrescens* (Lauraceae), *Mucuna* *hirsuta* (Papilionaceae), *Nilgirianthus* *heyneanus* (Acanthaceae), *Otonephelium* *stipulaceum* (Sapindaceae), *Premna* *glaberrima* (Verbenaceae), *Wendlandia* *notoniana* (Rubiaceae) are the hosts of undescribed taxa. The remainder of the endemic species are hosts of meliolaceous fungi previously unrecorded from India, but known from other tropical countries.

The large number of taxa of meliolaceous fungi found in the small area included in this study illustrates their abundance in the tropics. About one-third of the total taxa encountered have proven to be new. Is this due to a general lack of exploration in the tropics for the meliolaceous fungi, or is it due to the exploration of a area that has previously been totally unstudied? The answer can only be determined by further collecting in unexplored areas.

Results of the present study reveal the affinity of the meliolaceous fungi of India with those of North and South America, tropical Africa, China, and the islands of

Santa Domingo, Puerto Rico, Trinidad, Sri Lanka, Sumatra, Java, The Philippines, New Guinea, New Caledonia and Taiwan. In a paper on an Indian species of Meliolina, Hughes and Pirozynski (1985) stated: "To students of Indian fungi . . . puzzled by consistent similarities of the mycota of India, intertropical Africa and Australo-Papua/New Zealand, we offer a reminder: the mycological road from Ootacamund winds its way to Mysore through Gudalur, Brisbane and Entebbe."

The Genera Amazonia, Armatella, Asteridiella and Irenopsis

1. **Amazonia acronychiae** Hosagoudar, sp. nov. Fig. 3

Plagulae amphigenae, plerumque epiphyllae, subdensae, ad 3 mm diam., confluentes. Hyphae brunneae, subrectae, opposite lateque ramosae, dense reticulatae, cellulis 22-30 x 8-10 µm. Hyphopodia capitata alternata, antrorsa, recta vel curvula, 24-44 µm longa; cellula basali cuneata, 10-22 µm longa; cellula apicali ovata, clavata, angulosa vel irregulariter sublobata, 18-22 x 14-18 um. Mucronate hyphopodia numerosa, illis capitatis commixta, alternata vel opposita, conoidea vel ampullacea, 22-30 x 8-10 µm. Perithecia dispersa, applanate-globosa, ad 110 µm; sporae obovoidae, 4-septatae, constrictae, 42-46 x 20-22 µm.

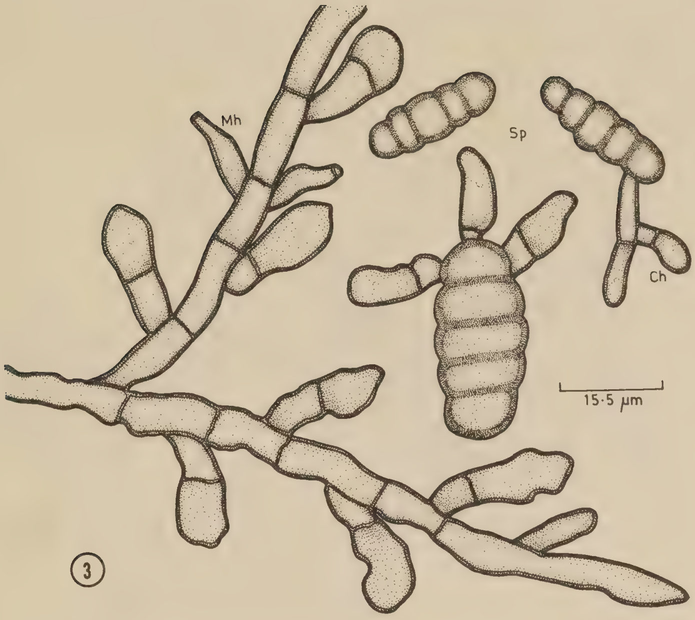
Colonies amphigenous, mostly epiphyllous, subdense, up to 3 mm in diameter, confluent. Hyphae substraight, branching opposite at wide angles, closely reticulate, cells 22-30 x 8-10 µm. Capitate hyphopodia alternate, closely antrorse, straight to curved, 24-44 µm long; stalk cells cuneate, 10-22 µm long; head cells ovate, clavate, angular to irregularly sublobate, 18-22 x 14-18 µm. Mucronate hyphopodia numerous, mixed with capitate hyphopodia, conoid to ampulliform, 22-30 x 8-10 µm. Perithecia scattered, flattened globose, up to 110 µm; spores obovoidal, 4-septate, constricted, 42-46 x 20-22 µm.

Holotype: On leaves of Acronychia pedunculata (L.) Miq. (Rutaceae), Lakshmi Estate, June 12, 1983, V.B. Hosagoudar HCIO 40463.

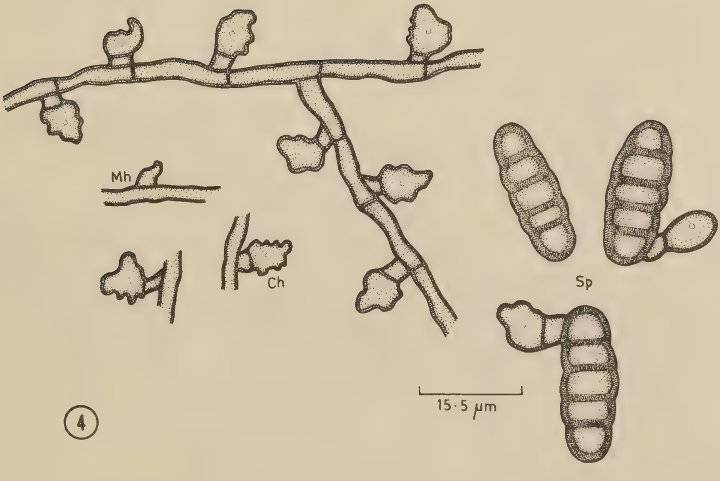
There is no record of the genus Amazonia on the members of the family Rutaceae (Hansford, 1961).

2. **Amazonia actinodaphnis** Hosagoudar, sp. nov. Fig. 4

Plagulae epiphyllae, densae, ad 5 mm diam., confluentes. Hyphae subrectae vel leniter undulatae, alternatim acuteque vel lateque ramosae, laxe reticulatae, cellulis 26-36 x 3-5 µm. Hyphopodia capitata alternata,



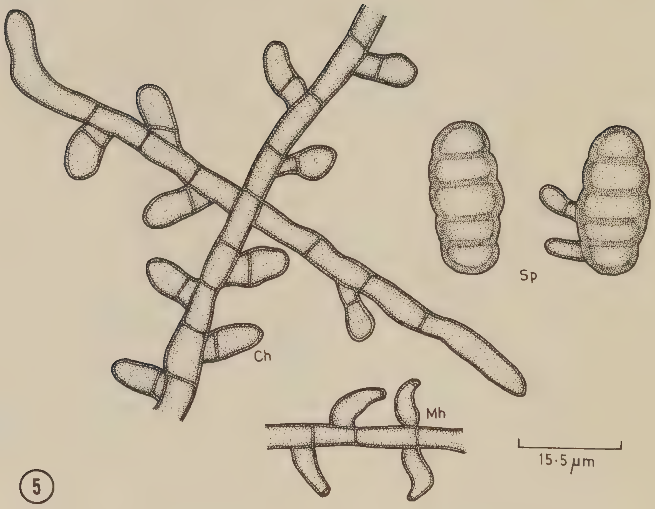
③



④

Figs. 3-11. New taxa of the Meliolaceae. Key to abbreviations: Ch = capitate hyphopodia. Mh = mucronate hyphopodia. Sp = ascospore. Pc = perithecial cell. Ps = perithecial setae.

Fig. 3 *Amazonia acronychiae* Hosagoudar. Fig. 4 *Amazonia actinodaphnis* Hosagoudar.


Ch
Sp
Mh
15·5 µm
5

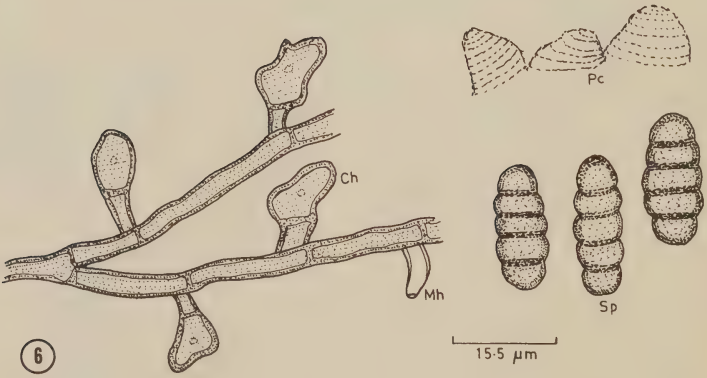
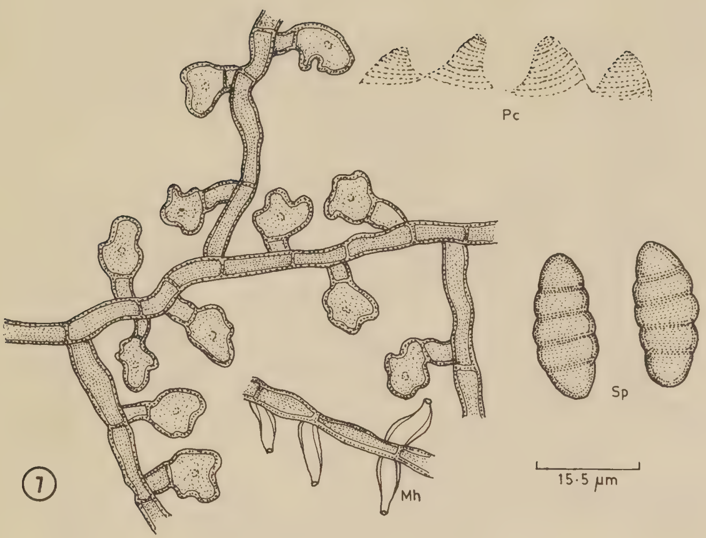

Pc
Ch
Mh
Sp
15·5 µm
6

Fig. 5. *Amazonia syzygii* Hosagoudar. Fig. 6. *Asteridiella clerodendricola* Hosagoudar.


Pc
Sp
15·5 μm
Mh
⑦

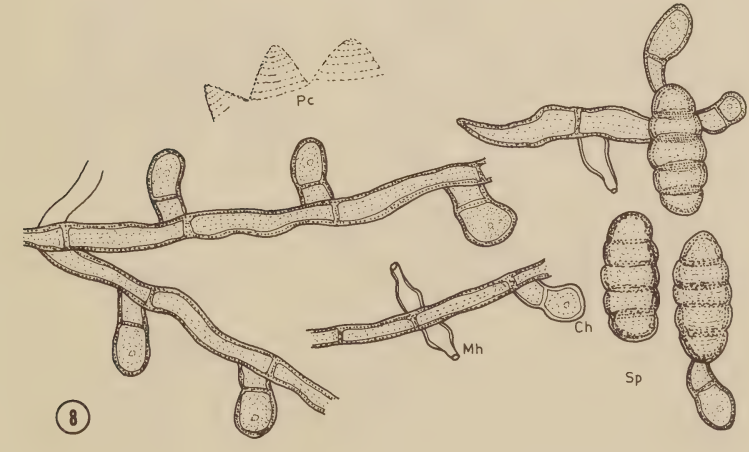
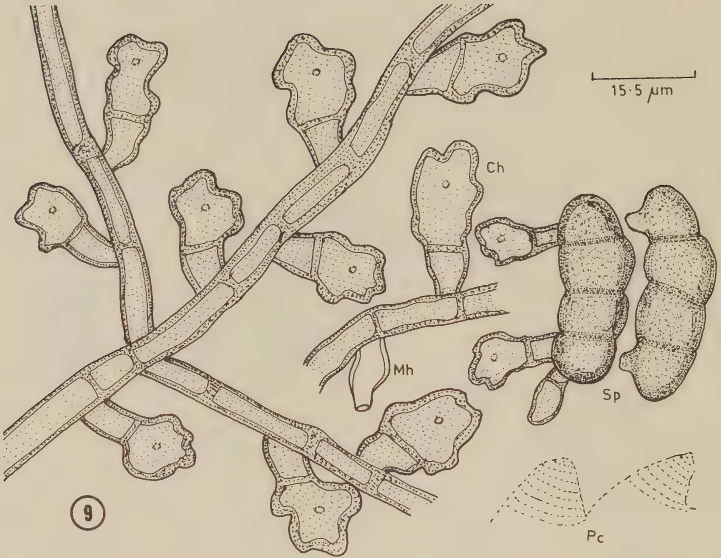
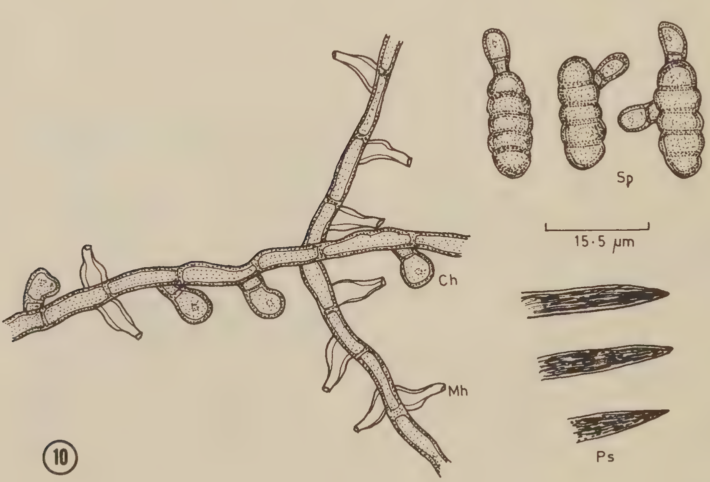


Fig. 7. Asteridiella crotonis Hosagoudar. Fig. 8. Asteridiella macarangicola Hosagoudar (drawn to the same scale as Fig. 7).


15·5 µm
Ch
Mh
Sp
Pc

9


Sp
15·5 µm
Ch
Mh
Ps

10

Fig. 9. *Asteridiella turpiniicola* Hosagoudar. Fig. 10. *Irenopsis eriolaenae* Hosagoudar.

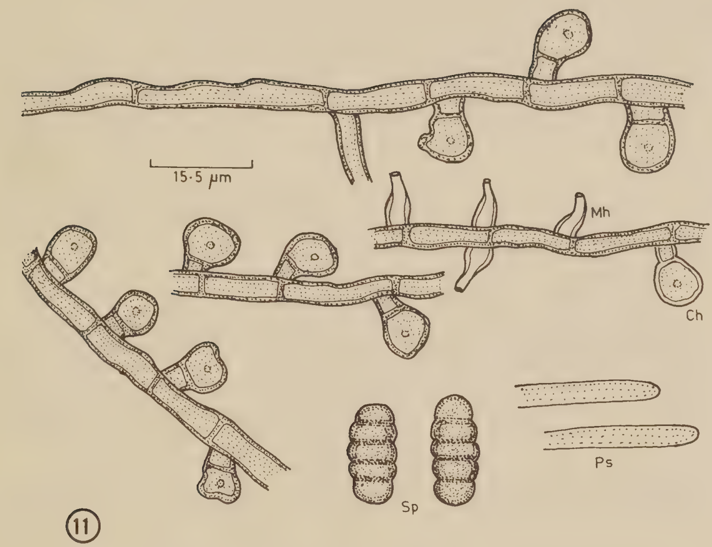

15·5 µm
Mh
Ch
Ps
Sp
11

Fig. 11. Irenopsis leeae Hansford var. indica Hosagoudar.

dispersa, antrorsa, patentia, recta vel curvula, 16.5-20 um longa; cellula basali cylindracea vel cuneata, 3-8 um longa; cellula apicali ovata, globosa, piriformia, stellate lobata, apice rotundata, 10-15 x 10-16.5 um. Mucronate hyphopodia pauca, illis capitatis commixta, alternata, ampullacea, 13-26.5 x 6-10 um. Perithecia acuteque dispersa, applanate-globosa, verrucosa, ad 165 um; sporae cylindraceae, 4-septatae, constrictae, 43-46 x 15-16.5 um.

Colonies epiphyllous, dense, up to 5 mm in diameter, confluent. Hyphae straight to slightly undulating, branching alternate at acute to wide angles, loosely reticulate, cells 26-36 x 3-5 um. Capitate hyphopodia alternate, scattered, antrorse, spreading, straight to curved, 16.5-20 um long. Stalk cells cylindrical to cuneate, 3-8 um long; head cells ovate, globose, pyriform, stellately lobate, rounded at the apex, 10-15 x 10-16.5 um. Mucronate hyphopodia few, mixed with capitate hyphopodia, alternate, ampulliform, 13-26.5 x 6-10 um. Perithecia closely scattered, flattened-globose, up to 165 um; spores cylindrical, 4-septate, constricted, 43-46 x 15-16.5 um.

Holotype: On leaves of Actinodaphne hookeri Meissn. (Lauraceae), Idukki, Oct. 11, 1982, V.B. Hosagoudar HCIO 40465; isotype: HCIO 40466.

A single species of Amazonia, viz. A. philippinensis Theiss. has been recorded on Ullolitsea villosa from the Philippines (Hansford, 1961). The present species differs from it in having substraight to undulating mycelia, stellately lobed head cells of the capitate hyphopodia, smaller perithecia and ascospores. Further, there is no record of the genus Amazonia on Actinodaphne hookeri.

3. **Amazonia peregrina** Sydow & Sydow, Ann. Mycol. 15:414, 1927; Hansford, Sydowia Beih. 2:507, 1961.

On leaves of Maesa indica (Roxb.) DC. (Myrsinaceae), Idukki, Jan. 10, 1982, V.B. Hosagoudar MH 72647; HCIO 40467.

This species occurs mostly on the leaves also infected with Meliola groteana Syd. but A. peregrina can be easily distinguished by its crustose colonies.

4. **Amazonia syzygii** Hosagoudar, sp. nov. Fig. 5

Plagulae amphigenae, subdense, crustosae vel leniter velutinae, ad 2 mm diam., raro confluentes. Hyphae subrectae vel leniter undulatae, plerumque opposite lateque ramosae, densae reticulatae, cellulis 16-20 x 6-8 um. Hyphopodia capitata alternata, recta, antrorsa vel patentia, 18-20 um longa, cellula basali cylindracea vel cuneata, 4-8 µm longa; cellula apicali ovata vel subglobosa, integra, 10-14 x 8-10 µm. Mucronate hyphopodia illis capitatis commixta, opposita vel alternata, conoidea vel ampullacea, 20-24 x 8-10 µm. Perithecia applanate-globosa, dispersa vel aggregata, ad 180 µm; sporae obovatae, 4-septatae, leniter constrictae, 44-48 x 16-20 µm.

Colonies amphigenous, subdense, crustose to slightly velvety, up to 2 mm in diameter, rarely confluent. Hyphae substraight to slightly undulating, branching mostly opposite at wide angles, closely reticulate, cells 16-20 x 6-8 µm. Capitate hyphopodia alternate, straight, antrorse to spreading, 18-20 µm long; stalk cells cylindrical to cuneate, 4-8 µm long; head cells ovate to subglobose, entire, 10-14 x 8-10 µm. Mucronate hyphopodia mixed with capitate hyphopodia, opposite to alternate, conoid to ampulliform, 20-24 x 8-10 µm. Perithecia flattened-globose, scattered to grouped, up to 180 µm; spores obovate, 4-septate, slightly constricted, 44-48 x 16-20 µm.

Holotype: On leaves of Syzygium cumini (L.) Skeels (Myrtaceae), Idukki, Dec. 13, 1982, V.B. Hosagoudar HCIO 40469. Isotype: MH 75742.

So far there is no record of the genus Amazonia on members of the family Myrtaceae (Hansf., 1961).

5. **Armatella cinnamomicola** Hansf., Reinwardtia 3:87, 1954.
On leaves of Cinnamomum malabatrum (Burm.f.) Blume (Lauraceae), Idukki, April 18, 1982, V.B. Hosagoudar MH 72696.

Hansford (1954) described this species from Indonesia. The present collection shows variations in having smaller capitate hyphopodia, larger perithecia and smaller ascospores.

6. **Armatella litseae** (P. Henn.) Theiss., Sydow & Sydow, Ann. Mycol. 13:235, 1915.

On leaves of Neolitsea zeylanica Merr. (Lauraceae), Lakshmi Estate, Dec. 6, 1983, V.B. Hosagoudar MH 78177, 78190; HCIO 40474.

7. **Asteridiella clerodendricola** Hosagoudar, sp. nov.
Fig. 6

Plagulae amphigenae, plerumque epiphyllae, densae, ad 10 mm diam., raro confluentes, maculae halonate, folia infecta corrugata. Hyphae mycelii tortuosae, alternatae vel oppositae lateque ramosae, densae reticulatae, cellulis 18-38 x 6-8 µm. Hyphopodia capitata alternata vel unilateralia, recta vel curvula, patentia vel antrorsa, 22-30 µm longa; cellula basali cylindracea vel cuneata, 8-16 µm longa; cellula apicali globosa, angulosa, integra vel sublobata, 14-18 x 12-16 µm. Mucronate hyphopodia pauca, illis capitatis commixta, opposita vel alternata, ampullacea, 20-22 x 8-10 µm. Perithecia plerumque aggregata, ad 245 µm; cellulis parietis irregulariter protrudo, 30-36 µm longis; sporae ellipsoidae, 4-septatae, recta vel leniter curvulae, 36-42 x 14-18 µm.

Colonies amphigenous, mostly epiphyllous, dense, scattered, up to 10 mm diameter, rarely confluent, causing stretching of the surrounding leaf surface with a yellow halo surrounding the spots. Hyphae strongly adpressed to the leaf surface, not easily separable, tortuous, branching alternate to opposite at wide angles, strongly reticulate, cells 18-38 x 6-8 µm. Capitate hyphopodia alternate to unilateral, straight to curved, antrorse to spreading, 22-30 µm long; stalk cells cylindrical to cuneate, 8-16 µm long; head cells globose, angulose, entire to sublobate, 14-18 x 12-16 µm. Mucronate hyphopodia few, mixed with capitate hyphopodia, opposite to alternate, ampulliform, 20-22 x 8-10 µm. Perithecia mostly aggregated, up to 245 µm; perithecial surface cells irregularly protruded, 30-36 µm long; spores ellipsoidal, 4-septate, straight to slightly curved, 36-42 x 14-18 µm.

Holotype: On leaves of Clerodendrum viscosum Vent. (Verbenaceae), Idukki, Dec. 22, 1983, V.B. Hosagoudar HCIO 40475. Isotype: MH 78998. Paratypes: Lakshmi Estate, Dec. 25, 1983, V.B. Hosagoudar MH 78998.

The infection was restricted to the young growing leaves. Two to many such infected spots on the leaves resulted in hypertrophy of the leaf, giving a peculiar appearance to the growing plant parts.

Twelve species of the genus Asteridiella have been recorded on various members of the family Verbenaceae. The present species differs in producing a pathogenic effect on the host plant.

8. **Asteridiella combreti** (Stev.) Hansf. var. **leonensis** Hansf., Sydowia Beih. 20:160, 1961.

On leaves of Terminalia paniculata Roth (Combretaceae), in the savanna of Idukki, Dec. 13, 1982, V.B. Hosagoudar HCIO 40476; V.B. Hosagoudar MH 75727, Jan. 24, 1983; V.B. Hosagoudar MH 75824; Dec. 27, 1983, V.B. Hosagoudar MH 78990; Oct. 4, 1983, V.B. Hosagoudar MH 78142.

9. **Asteridiella confragosa** (Sydow & Sydow) Hansf., Sydowia 10:47, 1957.

On leaves of _Trichosanthes_ _palmata_ Roxb. (Cucurbitaceae), Idukki, Oct. 8, 1983, V.B. Hosagoudar HCIO 40477; MH 78904; Dec. 12, 1983, V.B. Hosagoudar MH 79042.

10. **_Asteridiella crotonis_** Hosagoudar, sp. nov.
Fig. 7

Plagulae hypophyllae, densae, ad 5 mm diam. Hyphae subrectae vel undulatae, opposite laxe ramosae, laxe vel densae reticulatae et solidae, cellulis 18-24 x 6-8 µm. Hyphopodia capitata alternata vel unilateralia, patentia, antrorsa vel reflexa, 22-26 µm longa; cellula basali cylindracea vel cuneata, 6-8 µm longa; cellula apicali ovata, integra vel sublobata, 16-20 x 12-18 µm. Mucronate hyphopodia pauca, illis capitatis commixta, opposita vel alternata, ampullacea, 16-18 x 6-8 µm. Perithecia dispersa, ad 196 µm; cellulae parietis conoidae, 20-26 µm longae; sporae ellipsoideae, 4-septatae, constrictae, rectae vel curvulae, 44-48 x 16-20 µm.

Colonies hypophyllous, dense, up to 5 mm in diameter. Hyphae substraight to undulating, branching opposite at wide angles, loosely to closely reticulate and forming a solid mass of mycelia, cells 18-24 x 6-8 µm. Capitata hyphopodia alternate and unilateral, spreading, antrorse to reflexed, 22-26 µm long; stalk cells cylindrical to cuneate, 6-8 µm long; head cells ovate, entire to imperfectly lobate, 16-20 x 12-18 µm. Mucronate hyphopodia few, mixed with capitate hyphopodia, opposite to alternate, ampulliform, 16-18 x 6-8 µm. Perithecia scattered, up to 196 µm; perithecial cells conoid, 20-26 µm long; spores ellipsoidal, 4-septate, constricted, straight to slightly curved, 44-48 x 16-20 µm.

Holotype: On leaves of _Croton_ _reticulatus_ Heyne (Euphorbiaceae), Pamba, Oct. 10, 1983, V.B. Hosagoudar HCIO 40478.

Note: Six species of _Asteridiella_ have been reported on members of the family Euphorbiaceae, having the Beeli formula 3101.4220 (Hansford, 1961). Of these, _A_. _antidesmatis_ Hansf. and _A_. _drypeticola_ Hansf. are closest to the present species. However, _A_. _crotonis_ differs from _A_. _antidesmatis_ in having dense hypophyllous colonies and larger capitate hyphopodia. It differs from _A_. _drypeticola_ in the morphology and arrangement of the capitate hyphopodia, and in having larger ascospores. Further, there is no record of the genus _Asteridiella_ on this host genus.

11. **_Asteridiella cyclopoda_** (Stev.) Hansf., Sydowia 10:47, 1957 and Sydowia Beih. 2:619, 1961.

On leaves of Vernonia monosis Clarke (Asteraceae), Idukki, Oct. 6, 1983, V.B. Hosagoudar HCIO 40479; MH 78174.

The present collection varies slightly from the species description (Hansford, 1961) in forming hypophyllous colonies, and in having larger capitate hyphopodia and smaller perithecial cells.

12. **Asteridiella formosensis** (Yamam.) Hansf., Sydowia 10:48, 1957 and Sydowia Beih. 2:686, 1961.

On leaves of Callicarpa tomentosa (L) Murray (Verbenaceae), Pamba, Oct. 10, 1983, V.B. Hosagoudar MH 78929.

13. **Asteridiella macarangicola** Hosagoudar, sp. nov.
Fig. 8

Plagulae epiphyllae, tenues, indistinctae, ad 2 mm diam. Hyphae tortuosae, opposite vel alternate ramosae, laxe reticulatae, cellulis 38-44 x 6-8 µm. Hyphopodia capitata alternata, recta vel curvula, patentia, plerumque antrorsa, 20-28 µm longa; cellula basali cylindracea vel cuneata, 8-12 µm longa; cellula apicali globosa, ovata, integra, raro leniter angulosa, 12-16 x 6-10 µm. Perithecia dispersa, ad 180 µm; cellulis parietis conoideis, usque ad 14 µm longis; sporae ellipsoideae, 4-septatae, constrictae, 38-40 x 16-18 µm.

Colonies epiphyllous, thin, indistinct, up to 2 mm diameter. Hyphae tortuous, branching opposite to alternate, loosely reticulate, cells 38-44 x 6-8 µm. Capitate hyphopodia alternate, straight to curved, spreading, mostly antrorse, 20-28 µm long; stalk cells cylindrical to cuneate, 8-12 µm long; head cells globose, ovate, entire, rarely slightly angulose, 12-16 x 6-10 µm. Perithecia scattered, up to 180 um; perithecial cells conoid, up to 14 µm long; ascospores ellipsoidal, 4-septate, constricted, 38-40 x 16-18 µm.

Holotype: On leaves of Macaranga peltata Muell.-Arg. (Euphorbiaceae), Calvary Mount, Dec. 24, 1983, V.B. Hosagoudar HCIO 40481. Isotype: MH 75050. Paratype: Lakshmi Estate, Dec. 25, 1983, V.B. Hosagoudar MH 79054.

The present species is similar to A. erythrococcae Hansf. and A. hansfordii (Stev.) Hansf. but differs from both in forming inconspicuous colonies, tortuous mycelia, larger capitate hyphopodia, and in having entire head cells of the capitate hyphopodia and distinctly broader ascospores. Further, there is no record of the genus Asteridiella on this host genus.

14. **Asteridiella malloti** (Hansf. & Thirum.) Hansf., Sydowia 10:49, 1957.

On leaves of Mallotus philippinensis (Lam.) Muell. (Euphorbiaceae), Lakshmi Estate, Dec. 25, 1983, V.B. Hosagoudar HCIO 40482; MH 79098. On leaves of M. tetracoccus (Roxb.) Kurz, Pamba, Oct. 12, 1983, V.B. Hosagoudar MH 78950.

15. **Asteridiella turpiniicola** Hosagoudar, sp. nov.
Fig. 9

Plagulae amphigenae, plerumque hypophyllae, densae, ad 3 mm diam. Hyphae rectae vel subrectae, alternate vel opposite lateque ramosae, laxe vel densae reticulatae vel reticulato-intertextae, cellulis 16-32 x 8-12 µm. Hyphopodia capitata alternata, patentia, antrorsa, 26-30 µm longa; cellula basali cylindracea vel cuneata, 6-10 µm longa; cellula apicali globosa, stellate sublobata, 18-20 x 16-24 µm. Mucronate hyphopodia pauca, illis capitatis commixta, opposita vel alternata, 20-24 x 8-10 µm. Perithecia aggregata vel dispersa, ad 360 µm., appendiculae peritheciales larviformae, flexuosae, fulvus, simplices, patentiae, ad 196 µm longae et 7-8 um crassae, rotundae ad apicem, rectae vel tortuosae ad apicem; sporae fusiformae, plerumque curvulae, 3-septatae, constrictae, 44-56 x 16-20 µm.

Colonies amphigenous, mostly hypophyllous, dense, up to 3 mm in diameter. Hyphae straight to substraight, branching alternate to opposite at wide angles, loosely to closely reticulate and forming an almost solid mass of mycelia; cells 16-32 x 8-12 µm. Capitate hyphopodia alternate, spreading, antrorse, 26-30 µm long; stalk cells cylindrical to cuneate, 6-10 µm long; head cells globose, stellately sublobate, 18-20 x 16-24 µm. Macronate hyphopodia few, mixed with capitate hyphopodia, alternate to opposite, ampulliform, 20-24 x 8-10 µm. Perithecia aggregated to scattered, up to 360 µm; perithecial appendages larviform, wavy, golden-brown, simple, spreading, up to 196 µm long and 7-8 µm broad, tip obtuse, straight to twisted; spores fusiform, predominently curved, 3-septate, constricted, 46-56 x 16-20 µm.

Holotype: On leaves of Turpinia malabarica Gamble (Staphyleaceae), Idukki, April 4, 1982, V.B. Hosagoudar HCIO 40483. Isotype: MH 73701. Paratypes: Oct. 11, 1982, V.B. Hosagoudar MH 73623, 73630; Pamba, Oct. 10, 1983, V.B. Hosagoudar MH 78928; Idukki, Dec. 21, 1983, V.B. Hosagoudar MH 78961.

Note: Appendiculella turpiniae (Yamam.) Hansf. has been recorded on Turpinia formosana Nakai and T. pomifera DC. from Formosa and the Philippines (Hansford, 1961), having repent, abnormal mycelial setae and the perithecial appendages. The present collection differs from it in lacking the perithecial appendages, and in having smaller capitate hyphopodia, perithecia and ascospores.

Yamamoto (1941) described *Irenina turpiniae*. Later, Hansford (1961) transferred this species to *Appendiculella* as *A. turpiniae* (Yaman.) Hansford, noting two characteristics:

1. No species of *Meliola* is hitherto known with perithecial appendages.

2. The "mycelial setae" are quite different from those commonly found in the species of *Meliola*, where they are erect, but are closer to those found on the perithecia of species of *Irenopsis*. They differ in being produced around the base of the perithecium, on mycelial hyphae, and in being repent, as well as being longer than in the so far known species.

In the present material, also, the repent appendages (termed here as perithecial) arise from the subicle just below the perithecia. Such appendages have also been seen on the mycelia where there were no perithecia. These repent setae/appendages are neither perithecial nor mycelial setae. Hence the present material has been placed under the genus *Asteridiella*.

16. *Irenopsis benquetensis* Stev. & Rold. ex Hansf., Sydowia 26:311, 1963.

On leaves of *Ficus asperrima* Roxb.(Moraceae), Calvary Mount, Oct. 12, 1982, V.B. Hosagoudar MH 73639; Oct. 4, 1983, V.B. Hosagoudar MH 78155. On leaves of *Ficus gibbosa* Bl., Calvary Mount, Feb. 21, 1983, V.B. Hosagoudar MH 75890; Lakshmi Estate, Dec. 12, 1982, V.B. Hosagoudar MH 79073, 79078; Oct. 12, 1982, V.B. Hosagoudar MH 73639; Oct. 4, 1983, V.B. Hosagoudar MH 78155. On leaves of *Ficus hispida* L.f., Idukki, Oct. 11, 1983, V.B. Hosagoudar MH 78943.

17. *Irenopsis eriolaenae* Hosagoudar, sp. nov.
Fig. 10

Plagulae epiphyllae, tenues, dispersae, ad 3 mm diam., confluentes. Hyphae subrectae vel undulatae, alternatae vel oppositae lateque ramosae, laxe reticulatae, cellulis 30-34 x 6-8 µm. Hyphopodia capitata alternata vel unilateralia, recta, antrorsa vel patentia, 14-16 µm longa; cellula basali cylindracea vel cuneata, 4-5 µm longa; cellula apicali ovata, clavata, integra vel leniter angulosa, 10-12 x 8-10 µm. Mucronate hyphopodia illis capitatis commixta vel in hyphis distinctis evoluta, alternata vel opposita, ampullacea, 12-20 x 6-8 um. Perithecia dispersa, verrucosa, ad 110 um; setae peritheciales 8-12, rectae, simplices, olivaceo-brunneae, septatae, ad apices acutae vel obtusae, ad 72 um longae et 6-8 um crassae; sporae obovoidae, 4-septatae, constrictae, 32-38 x 10-14 um.

Colonies epiphyllous, thin, scattered, up to 3 mm in diameter, confluent. Hyphae substraight to undulating, branching alternate to opposite at wide angles, loosely reticulate, cells 30-34 x 6-8 um. Capitate hyphopodia alternate to unilateral, straight, antrorse to spreading, 14-16 um long; stalk cells cylindrical to cuneate, 4-5 um long; head cells ovate, clavate, entire to slightly angular, 10-12 x 8-10 um. Mucronate hyphopodia mixed with capitate hyphopodia and borne on a separate mycelial branch, alternate to opposite, ampulliform, 12-20 x 6-8 um. Perithecia scattered, verrucose, up to 110 um; perithecial setae 8-12, straight, simple, septate, olivoceous brown, acute to obtuse at the tip, up to 72 um long and 6-8 um broad; spores obovoidal, 4-septate, constricted, 32-38 x 10-14 um.

Holotype: On leaves of Eriolaena quinquelocularis (Wight & Arn.) Wight (Sterculeaceae), Idukki, Dec. 23, 1983, V.B. Hosagoudar HCIO 40487. Isotype: MH 79027.

The present species is close to I. tjibodense Hansf., recorded on Pterospermum javanicum Fungh., and P. niveus Vidal from Java and the Philippines (Hansford, 1961), but differs in having smaller capitate hyphopodia, perithecia and perithecial setae; absence of radiate exhyphopodiate mycelia below the perithecia, in having mucronate hyphopodia mixed with capitate hyphopodia which are also borne on separate mycelial branches. Further, there is no record of meliolaceous fungi on this host genus.

18. **Irenopsis leeae** Hansf. var. **indica** Hosagoudar, var. nov. Fig. 11

Differt a I. leeae Hansf. var. leea hyphopodiis capitatis alternatis et myceliis subrectis ad undulatis. Differt a I. leeae Hansf. var. javensis Hansf. Plagulis tenuibus, hyphis subrectis ad undulatis lateque ramificantibus.

Colonies epiphyllous, very thin, up to 3 mm in diameter. Hyphae straight to undulating, branching opposite to alternate at wide angles, loosely reticulate, cells 18-28 x 6-8 um. Capitate hyphopodia scattered, alternate to unilateral, closely antrorse, 18-24 um long; stalk cells cuneate, 6-10 um long; head cells ovate, globose, entire to irregularly sublobate, 10-18 x 16-20 um. Mucronate hyphopodia numerous, mixed with capitate hyphopodia, alternate to opposite, ampulliform, 16-22 x 8-10 µm. Perithecia scattered to grouped, verrucose, up to 150 um; perithecial setae 3-8, straight to flexuous, spreading, dark at the base and paler towards the apex, tip obtuse, 84-150 x 8-10 µm; spores obovoidal, 4-septate, constricted, 30-36 x 12-16 µm.

Holotype: On leaves of Leea indica (Burm. f.) Merr. (Leeaceae), Kanchiar forest, Dec. 17, 1982, V.B. Hosagoudar HCIO 40488. Isotype: MH 75795.

Paratypes: Kanchiar forest, Dec. 17, 1982, V.B. Hosagoudar MH 75795; Dec. 23, 1983, V.B. Hosagoudar MH 79032; Reservoir side of Calvary Mount, Dec. 24, 1983, V.B. Hosagoudar MH 79069; Lakshmi Estate, Dec. 25, 1983, V.B. Hosagoudar MH 79088.

The new variety indica differs from var. leea in having alternate capitate hyphopodia and substraight to undulating mycelia. It also differs from I. leeae Hansf. var. javensis Hansf. in having thin colonies, substraight to undulating mycelia and branching at wide angles.

19. Irenopsis triumfettae (Stev.) Hansf. & Deight., Mycol. pap. 23:14, 1948.

On leaves of Triumfetta pilosa Roth (Tiliaceae), Lakshmi Estate, Dec. 14, 1982, V.B. Hosagoudar, HCIO 40489; MH 75746; Calvary Mount, Dec. 15, 1982, V.B. Hosagoudar MH 75779; Dec. 28, 1983, V.B. Hosagoudar MH 80322; Oct. 6, 1983, V.B. Hosagoudar MH 78175, 78176. On leaves of Triumfetta rhomboides Jacq., Pamba, Oct. 10, 1983, V.B. Hosagoudar MH 78935.

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CULTURAL, ENZYMATIC AND CYTOLOGICAL STUDIES IN THE GENUS PHOLIOTA

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SUMMARY

Mycelial cultures of 14 species of the genus **Pholiota** Kummer (**Basidiomycotina, Agaricales**) together with **Kuehneromyces mutabilis** (Schaeff.: Fr.) Sing. et Smith species have been studied. The morphological, microscopical, cultural and cytological characteristics of the species and their enzymatic activity are presented. Emphasised are the features applicable for the taxonomy of the genus. These results have been used to arrange the dichotomic key for determination af all the species.

INTRODUCTION

Study of **Basidiomycetes** in pure cultures is one of important but still little spread taxonomic methods. Nobles (1965) suggested the use of cultural characters in developing a taxonomy of the **Polyporaceae** that reflects natural relationship and phylogeny. Study of **Basidiomycetes** in pure cultures has mostly been pursued on wood-decaying basidiomycetes. Nobles (1948) provided an 11-character key pattern and description based on cultural information to 126 basidiomycetes that decay wood. Other studies were done, e. g., by Boidin (1958), Siepmann and Zycha (1968), Siepmann (1969), Boidin and Languetin (1983), Job (1968), Adaskaveg and Gilbertson (1989). Some **Agaricales** in pure cultures were studied by Lyman (1907), Kühner (1946, 1947), Semerdžieva (1965), Pantidou et al. (1983), Buchalo (1988).

The genus **Pholiota** that includes mostly wood-decaying species, has been studied relatively often (Sawyer, 1917; Martens and Vandendries, 1933; Smith and Brodie, 1935; Deneyer, 1960; Farr et al., 1977; Hübsch, 1978; Arita, 1979; Arita et al., 1980) but the studies concerned only a few generally occurring species. No comprehensive comparative study of a larger number of species including rare ones has so far been undertaken.

MATERIAL AND METHODS

The culture used were from the collection of macromycetes cultures, Institute for Toxicology, Charles University in Prague (Klán and Štípek, 1987). The species under study are as follows: **Pholiota destruens** (Brond.) Quél. s. l., (year of isolation 1965)

- Sect. **Hemipholiota; Ph. squarrosa** (Müll.: Fr.) Kumm., (strain I-1985, II-1986) - Sect. **Pholiota; Ph. adiposa** (Batsch: Fr.) Kumm., (1983); **Ph. conifera** (Karst.) Karst. (1984); **Ph. flammans** (Fr.) Kumm. (1982); **Ph. jahnii** Tjall. et Bas (1979); **Ph. lucifera** (Lasch) Quél., (1978); **Ph. squarroso-adiposa** Lange (1986) - Sect. **Adiposae; Ph. alnicola** (Fr.) Sing. (1983); **Ph. flavida** (Schaeff.: Fr.) Sing. (I-1980, II-1983) - Sect. **Flammula; Ph. gummosa** (Lasch) Sing. (I-1975, II-1982) - Sect. **Subsiccae; Ph. carbonaria** (Fr.: Fr.) Sing. (I-1986, II-1986, III-1977); **Ph. lenta** (Pers.: Fr.) Sing. (1983); **Ph.spumosa** (Fr.) Sing. (1983) - - Sect. **Lubricae; Kuehneromyces mutabilis** (Schaeff.: Fr.) Sing et Smith (1983).

All isolates were cultivated on malt extract agar - MEA (agar 15 g, malt extract (Difco) 10 g, demineralized water 1000 ml, pH 6 - 6.5) in Petri dish 90 mm in diameter, with 20 ml medium. They were inoculated by means of strike cork borer 8 mm in diameter. Incubation was carried out in the dark in a thermostat at 24° C ± 0,5° C.

Cultural characteristics were examined after 14-21 day cultivation. The following features were examined: colony colour (after Kornerup and Wanscher 1984), the texture of the mycelial mat, margin of the colony, growing zones, colour change in the agar induced by the fungus, odour, guttation. Growth rate was evaluated as well. Cultural characteristics were examined microscopically (oil immersion magnif. 1000 x using Melzer´s reagent and phloxine). Macro and micro characteristics were completed by changes after one, 3 and 9 months cultivation. Spontaneous fructification is mentioned wherever observed. The HCl-Giemsa method (fixation: ethanol-glacial acetic acid 3:1, hydrolyse 7´ at temperature 60° C in 1 M HCl, staining 30´ at 30° C) was used for caryological study.

Asexual reproductive structures. As some authors call certain structures of the genus **Pholiota** by different names, we are describing the structures observed as follows: arthrospores (according to other authors "oidia, arthroconidia") - - reproductive structures formed seriately by fragmentation of the hyphae, thin walled, 1-2 (or more) nuclei. Conidia - - reproductive structures formed on conidiophores, often vertically on vegetative hyphae, thin-walled, 1-2 (or more) nuclei. Aleurospores (according to some authors "chlamydospores") - - terminally forming structures, often on conidiophore, thick walled. Allocysts - swollen cells with thin or slightly thick wall. They are not reproductive structures.

Enzymatic activity has been studied. Oxidoreductases: 1. Spot tests (laccase - as substrate used syringaldazine; peroxidase - p-phenylendiamine tartrate and 3 % H_2O_2; catalase - 10 % H_2O_2). 2. Plate diffusion method (tyrosinase - L-tyrosin); all oxidoreductases according to Klán and Baudišová (1989 b). Hydrolases 1. Plate diffusion methods (lipase - Tween 80; lecithinase - soybean lecithin; amylase - starch and Lugol solution; protease - gelatine or dried milk; milk clotting enzymes - - dried milk; urease - urea and phenol red; according to Klán and Baudišová, 1989 a) and cellulase - 1.5 % agar, 1 % pepton, 1 % microcrystalline cellulose, pH 6.5. After six day incubation, the Petri dishes were overlaid with 1 ml 1 M HCl and 5 ml 0,5 % Iodine solution in 2 % KI. 2. Cytochemical methods (α-glucosidase - 6-brom-2-naphtyl-α-D-glucopyranoside, ß-galactosidase - 6-brom-2-naphtyl-ß-D-galactopyranoside; Klán et al., 1989).

RESULTS

Macroscopic and microscopic descriptions are given of cultures of 14 species of the genus **Pholiota** and the species **Kuehneromyces mutabilis**, including their enzymatic activities (see Tab. 1). A key is suggested for determining mycelial cultures of the species under study according to characteristic features.

Pholiota adiposa (Batsch: Fr.) Kumm.

The culture grows well, the colony attaining a 80 mm diameter in 15 days. The growth does not alter the colour of the nutrient medium. Aerial mycelium is sparsely woolly, with outlined advancing zones and radial filaments. The profile is flat. The colony margin is regular, inconspicuosly demarcated, finely ciliate; marginal hyphae do not grow into the substrate. The colour is whitish: during ageing the culture becomes yellow in the direction from the centre. (Tab. 4, 5A according to the colour scale of Kornerup and Wanscher 1984). The odour is inconspicuous; no guttation has been observed.

Aerial hyphae are thin-walled, 1.2 - 3.3 µm diam. Clamp connections are very frequent, on nearly every septum. Anastomoses are rare, branching very rare. Conidia 5.2 - 10.5 x 2.1 - 3.0 µm, bullet-shaped, elongate or cylindrical, observed already from day 14 of the culture age (Fig. 1). After 28 days conidia very frequent, as a rule separated from conidiophores.

A 9-month old culture observed to contain, in addition to conidia, also aleurospores of a cylindrical (7 x 12 µm) to more or less spherical shape, with slightly thickened wall (Fig. 1).

Hyphae dikaryotic, conidia most often dikaryotic, rarely 1, 3 or 4-nucleate.

Ref.: Arita (1979), Arita et al. (1980), Buchalo (1988), Buchalo et al. (1971, 1985), Hashioka and Arita (1978), Hübsch (1978), Käärik (1965), Nerud et al. (1982), Nobles (1948), Mišurcová (1987), Rypáček (1957).

Pholiota alnicola (Fr.) Sing.

The culture grows very slowly, the colony attaining a diameter of 62 mm after 44 days. The growth does not alter the

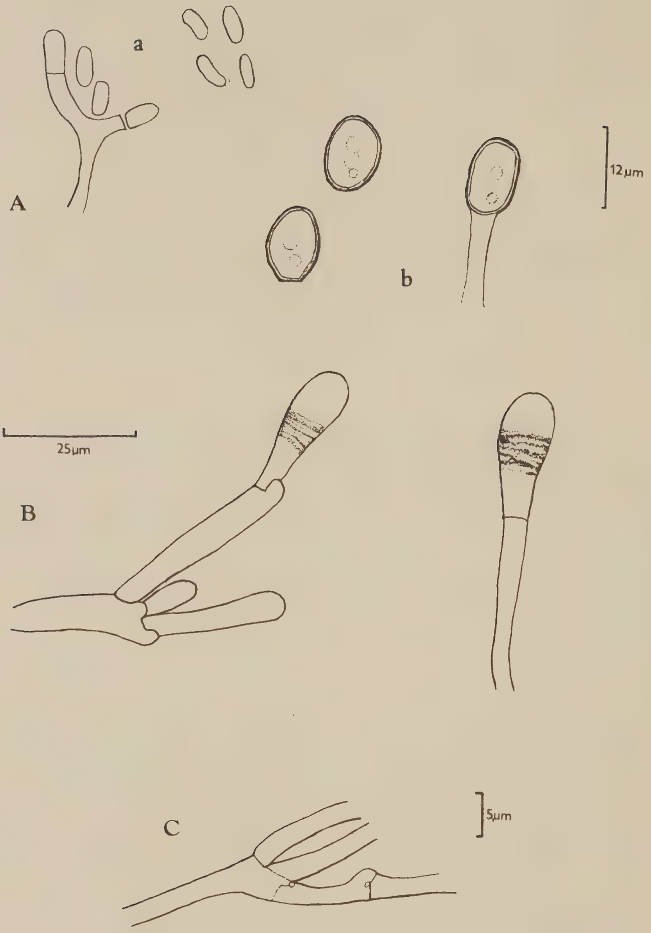

a
A
12µm
b
25µm
B
C
5µm

Fig. 1 A- **Pholiota adiposa**, a) conidia on conidiophore b) aleurospores, B- **Ph. jahnii**, club-like terminal cells with incrusted wall, C- **Ph. spumosa**, branching on hyphae

medium hue. Aerial mycelium is very finely woolly, low, with demarcated growth zones. Profile flat, colony margin irregularly shallowly lobate with fine ciliate. Colour pastel yellow (Tab. 3, 4A), most intensive in the inoculum, becoming more intensively yellow on ageing. Odour conspicuous; guttation not observed.

Aerical hyphae are thin-walled, 2.1 - 3.0 µm wide. Clamp connections on each septum. Anastomoses present, branching relatively frequent. Allocysts 10-15 um in diameter branch off the main hypha (usually at an angle of 90°), the branching hypha usually carries a clamp connection (Fig. 2). Intercalary allocysts also observed (a hypha 2.5 µm in diameter extends after the septum with a clamp connection to up to 5-7 µm wide swelling).

9-month old culture without change.
Hyphae and allocysts dikaryotic.

Ref.: Deneyer (1960), Käärik (1965), Kühner (1947), Nobles (1965).

Pholiota carbonaria (Fr.: Fr.) Sing.

The culture grows very well (colony diameter 80 mm in 7 days). The growth does not alter the colour of the medium. Aerial mycelium finely and sparsely filamentous, no advancing zones observed. Profile flat. Colony rim even, inconspicuously demarcated, finely ciliate. Peripheral hyphae do not grow into the substrate. Colour whitish, no changes observed in the character of the mycelium on ageing. The culture produces readily fruiting bodies under laboratory conditions.

Aerial hyphae thin-walled, 1.2 - 3.1 µm diam. Clamp connections frequent, on nearly every septum. Anastomoses noticed, branching not too frequent, hyphae originate at a 90° angle. Anamorphs not observed.

A 9-month old culture without change.
Hyphae dikaryotic.

Ref.: Hübsch (1978).

Pholiota conifera (Karst.) Karst.

Syn.: **Pholiota aurivella** (Batsch: Fr.) Kumm.

The culture grows well (colony diameter 80 mm in 18 days). The growth does not alter the colour of the medium. Aerial mycelium finely woolly with perceptible radial filaments, growth zones not observed. Profile disc-shaped. Colony margin finely ciliate. Colour white, turning yellow from the inoculum with ageing (Tab. 4, 6A). Odour musty, guttation not observed. Prolonged culturing in a refrigerator on malt agar produces primordia with partial differentiation.

Aerial hyphae thin-walled, 1.2 - 3 µm diam. Clamps frequent. Anastomoses present, lateral branches originate at the site of the septum as well as outside it, at an angle of 60 - 90°. Be-

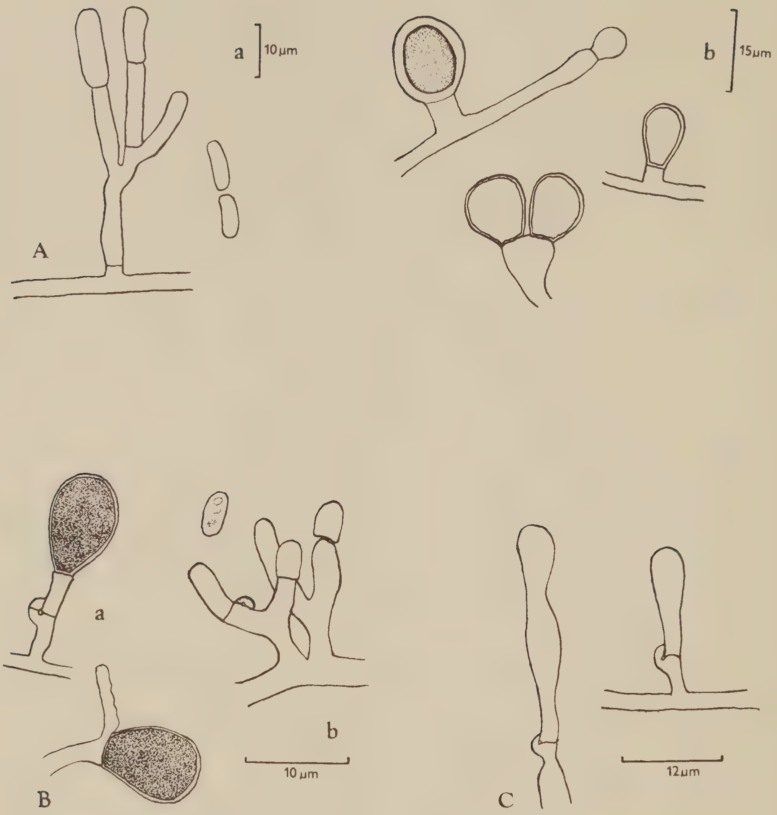

a
10µm
b
15µm
A
a
b
10 µm
B
C
12µm

Fig. 2 A- **Pholiota conifera**, a) conidia on conidiophore b) aleurospores, B- **Ph. gummosa** a) aleurospores, b) conidia on conidiophore, C- **Ph. alnicola**, allocysts

ginning on day 10 cylindrical conidia 5-12x2.1-7 µm observed (Fig. 2). Conidiophores 35-40 µm long, multiple branching.

A 9-months old culture contains cylindrical (5x15 µm) to spherical aleurospores with thickened walls (Fig. 2).

Hyphae dikaryotic, conidia most often dikaryotic, rarely 1, 3, 4 or 5-nuclear.

Ref.: Buchalo (1988), Buchalo et al. (1971, 1985), Hashioka and Arita (1978), Hůbsch (1978), Käärik (1965), Nerud et al. (1982); Nobles (1965), Pantidou et al. (1983), Rypáček (1957), Watling (1983).

Pholiota destruens (Brond.) Quél. s.l.

The culture grows very slowly (colony diameter 80 mm after 52 days). The growth does not alter the colour of the medium. Aerial mycelium finely powdery with coarser sprinkling, very low, growing zones not observed. Profile flat. Colony margin sharply demarcated, very finely ciliate. Colour yellowish white (Tab. 3, 2A). Odour inconspicuous, guttation yellowish.

Microscopic description available only for submerged mycelium. Hyphae thin-walled, 1.8 - 2.2 µm diam. Clamp connections frequent, septa without clamp connections also observed. Anastomoses rare, lateral hyphae originate at an angle of 30-60° most often at the site of the septa. Anamorphs not observed.

A 9-month old culture without changes.

Ref.: Hübsch (1978), Käärik (1965), Kühner (1946), Rypáček (1957).

Pholiota flammans (Fr.) Kumm.

The culture grows very well (colony diameter 80 mm after 18 days). The growth does not alter the colour of the medium. Aerial mycelium finely woolly, low, with radially extending hyphae. Advancing zones not observed. Profile flat. Colony margin even, inconspicuously demarcated, marginal hyphae do not grow into the substrate. Colour pale yellowish white (Table 2, A2), mycelial character does not change during ageing. Odour faint; guttation not observed. One-year culturing in a refrigerator on an apple-carrot medium produces well developped primordia.

Aerial hyphae thin-walled, 1.1-3.0 µm diam. Clamp connections very frequent, on almost every septum. Anastomoses very frequent, projections very rare, branching fairly frequent. No anamorphs observed after a 1-month cultivation, after 3 months discernible aleurospores with a thin wall which becomes thickened on ageing. They are 15x30 µm in size, round to pyriform (Fig. 3).

A 9-month old culture contains as a rule thick-walled aleurospores.

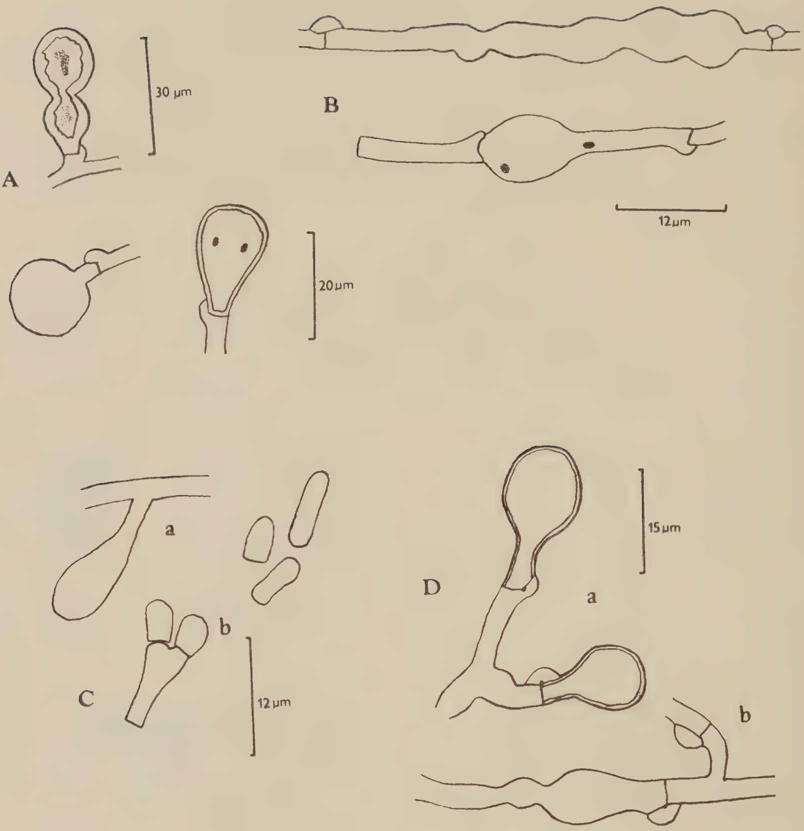

A
30 µm
B
12µm
20µm
a
b
C
12µm
D
a
15µm
b

Fig. 3 A- **Pholiota flammans**, aleurospores, B- **Ph. lucifera** allocysts, C- **Ph. squarroso-adiposa**, a) allocyst, b) conidia, D- **Ph. flavida** a) aleurospores, b) intercalary thickened hyphae

Hyphae most often dikaryotic but also monokaryotic, aleurospores mono- or dikaryotic.

Ref.: Käärik (1965).

Pholiota flavida (Scheff.: Fr.) Sing.

Strain I grows very slowly (colony diameter 65 mm after 50 days), strain II grows moderately (80 mm after 28 days). Medium turns dark during growth. Aerial mycelium powdery, at certain sites finely flocculate, very low, with perceptible radial arrangement of hyphae. Colony margin delineated, finely ciliate. Colour yellowish, at the site of the inoculum more intensively light yellow (Table 4, A5). Odour pleasant but inconspicuous, guttation not observed.

Aerial hyphae thin-walled, 1.1 - 2.5 µm diam. Clamp connections frequent, on almost every septum. Anastomoses very frequent, branching frequent, hyphae of uniform diameter branch off usually at an angle of 90°. Frequent terminal coils on hyphae 35-80 µm in diameter. Aleurospores 15-25x15-11 µm, pyriform or bottle-shaped, are formed on a hyphae with a clamp connection (Fig. 3), in a Melzer reagent they are filled with a yellow substance. Intercalary thickened hyphae 65-66 µm also rarely present (Fig. 3).

A 9-month old culture without changes.

Hyphae dikaryotic, aleurospores also dikaryotic, rarely monokaryotic.

Ref.: Hübsch (1978).

Pholiota gummosa (Lasch) Sing.

The culture grows well (colony diameter 80 mm after 9 days). The growth does not alter the colour of the medium. Aerial mycelium very sparsely woolly, surface grosty. Profile flat. Colony margin even, inconspicuously demarcated, peripheral hyphae do not grow into the substrate. Colour whitish, ageing produces fine powdery to groaty sprinkling, greyish orange to yellowish brown (Table 5, B5 - Table 5, D8), in the direction from the inoculum. Odour pleasant. Guttation yellow-brown.

Hyphae thin-walled, 2.5 - 3.1 µm diam. Clamp connections very frequent, on almost every septum. Anastomoses observed, branching very frequent, hyphae branch of at an angle of 60-90°. Aleurospores 7-13x3-5 µm, bottle-shaped, pyriform to round (Fig. 2). In Melzer reagent they are filled with an amorphous yellow substance. After aleurospores there appear conidia 1.5-3x5-10 µm in size, oval or bullet-shaped, sometimes with sharp or rounded edges (Fig. 2). Yellowish droplets observed in Melzer reagent.

A 9-month old culture without changes.

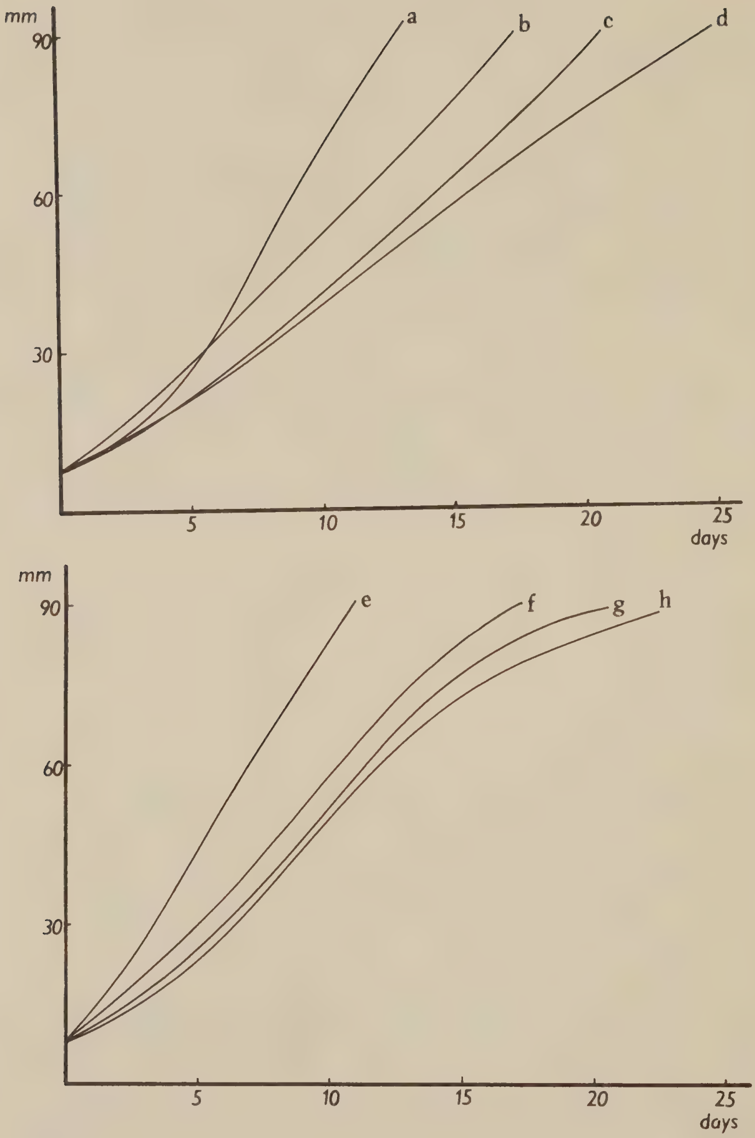


Fig. 4 Growth curves of the species, a) Pholiota gummosa, b) Ph. adiposa, c) Ph. squarroso-adiposa, d) Ph. conifera, e) Ph. carbonaria, f) Kuehneromyces mutabilis, g) Ph. flammans, h) Ph. lucifera

Hyphae and conidia dikaryotic, aleurospores observed to have 2 or 4 nuclei, more rarely 1 or 3.

Ref.: Deneyer (1960), Hübsch (1978), Käärik (1965), Kühner (1946).

Pholiota jahnii Tjall. et Bas

Syn.: **Pholiota muelleri** (Fr.) Orton

The culture grows very slowly (colony diameter 20 mm after 90 days). Aerial mycelium velvety. Profile high, convex, irregularly puckered. Peripheral hyphae grow into the substrate. Colour pale yellow (Table 3, A3). Odour inconspicuous, guttation not observed. A 1-year incubation in a refrigerator on malt agar yielded partially developed primordia.

Hyphae thin walled, 1.0-3.5 µm diam. Clamp connections frequent. Anastomoses not observed, hyphal branching rare.

After 9 months frequent club-like terminal cells of hyphae, with incrusted wall (Fig. 1).

No references.

Pholiota lenta (Pers.: Fr.) Sing.

The culture grows moderately well (colony diameter 80 mm after 28 days). The growth does not alter the colour of the medium. Aerial mycelium is very finely powdery, with tiny groat-like sprinkling in the region of the inoculum. No advancing zones were observed. Profile flat, colony margin even, without marked delineation. Colour whitish, with central yellowing. Odour inconspicuous, guttation not observed.

Hyphae thin-walled, 2.5-4 µm diam., with numerous septa. Clamp connections very frequent. Anastomoses not observed, branching frequent, especially in submerged mycelium.

Anamorphs not observed.

A 9-month old culture without change.

Hyphae dikaryotic.

Ref.: Hashioka and Arita (1978), Hübsch (1978), Kühner (1946), Marr et al. (1979).

Pholiota lucifera (Lasch) Quél.

The culture grows moderately well (colony diameter 80 mm after 24 days). The growth does not alter the colour of the medium. Aerial mycelium with marked radial filamentation. The mycelial mat is denser in the centre and looser at the periphery, with tree-like arrangement. Colony margin with long filaments, hyphae do not grow into the substrate. Profile flat. Mycelium colour white, with greyish-orange stripes spreading radially

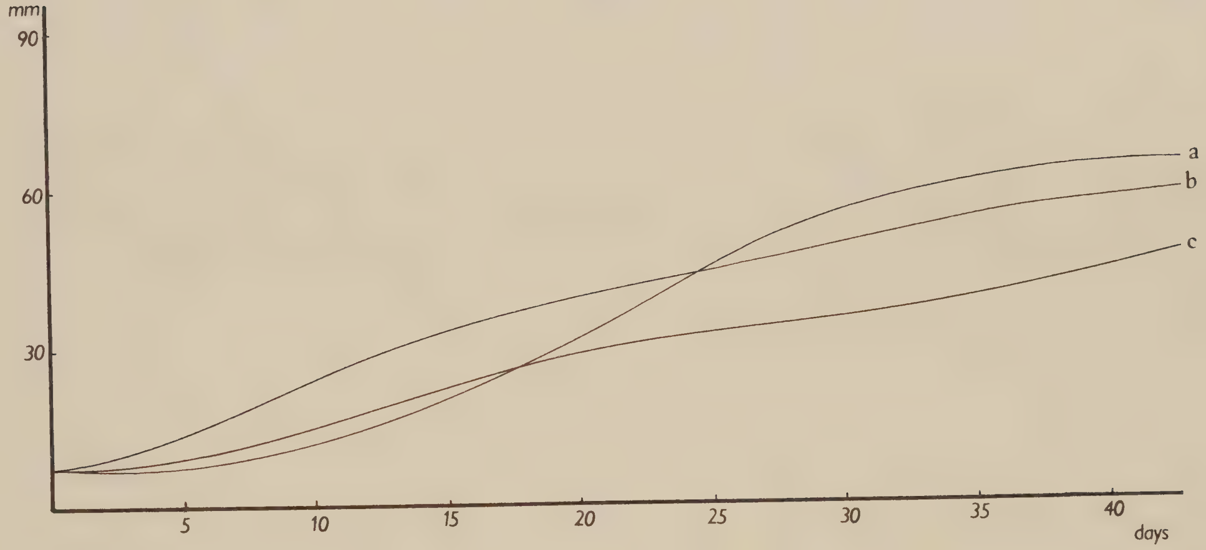


Fig. 5 Growth curves of the species, a) Pholiota destruens, b) Ph. alnicola, c) Ph. squarrosa

(Table 5, B5). Odour fungal, guttation not observed.

Aerial hyphae are thin-walled, 1.0-3.3 µm diam. Clamp connections very frequent, septa without clamps observed as well. Anastomoses present, branching very frequent. Hyphae sometimes with club-like ends, sometimes with terminal coils, hyphal wall often corrugated, hyphal cells always bonded by two clamps. Frequent allocysts round to ovoid, 12x17 µm (Fig. 3).

A 9 month old culture without change.

Both hyphae and allocysts dikaryotic.

Ref.: Kühner (1946).

Pholiota spumosa (Fr.) Sing.

The culture grows very slowly (colony diameter 80 mm after 60 days). Discolouration of nutrient medium during growth. Mycelium for the most part densely woolly, compact, at places the mycelium thinner. Profile flat. Colony margin markedly lobate. In places the margin irregularly demarcated with a woolly flucculose character, sometimes with circular islets separated from the main colony. Colour white. Odour inconspicuous, guttation not observed.

Hyphae thin-walled, 1.2x4.8 µm diam. Clamp connections frequent, septa without clamps also observed. Anastomoses observed, branching abundant (Fig. 1), frequent connections via clamps.

A 9-month old culture without change.

Hyphae dikaryotic.

Ref.: Hashioka and Arita (1978).

Pholiota squarrosa (Müll.: Fr.) Kumm.

The culture grows very slowly (colony diameter 74 mm after 57 days). Nutrient medium turns darker during growth, more conspicuously in strain II. Aerial mycelium woolly to flocculose, finely groaty in the centre. Profile flat. Colony margin delineated. Colour whitish, on ageing turning gradually darker - - light yellow (Table 4, A4) to greyish orange (Table 5, B5). Odour unpleasant, musty, guttation very fine, colourless. Fructification recorded on malt agar in a refrigerator.

Aerial hyphae thin-walled, 1.0-2.0 µm diam. Clamp connections frequent, septa without clamps also frequent. Anastomoses observed, branching not very frequent. After 3 months conidia observed very rarely, belonging to two types: cylindrical 8-3 µm, and pear-shaped or club-like, 6-12x4-7 µm; mostly unicellular but also bi- or tricellular. Both types of conidia arise often on a single conidiophore.

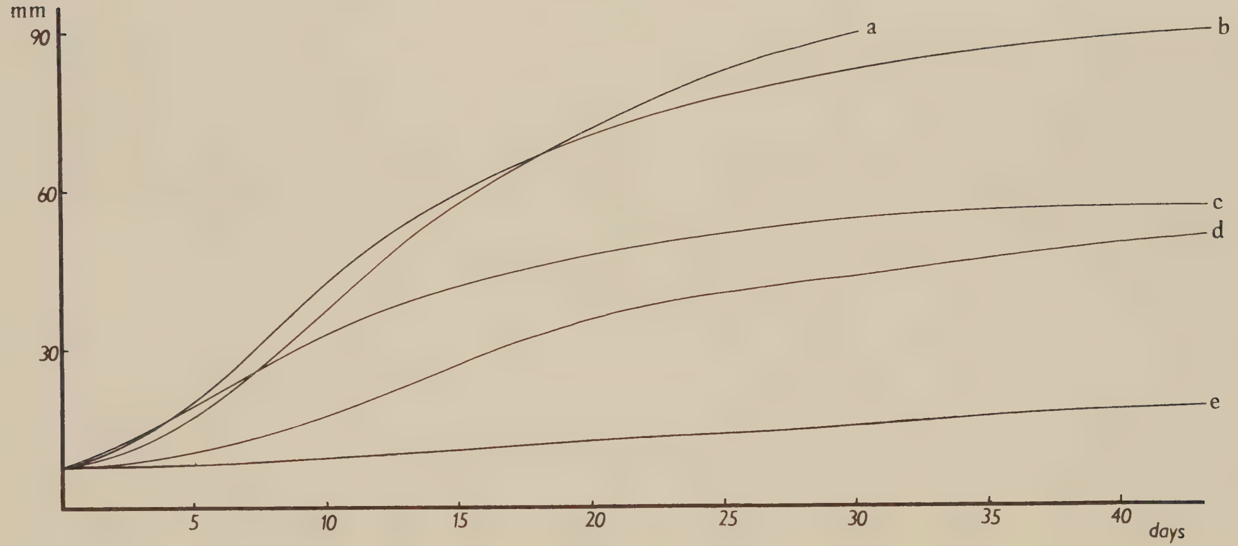


Fig. 6 Growth curves of the species, a) **Pholiota flavida** (strain II), b) **Ph. lenta**, c) **Ph. spumosa**, d) **Ph. flavida** (strain I), e) **Ph. jahnii**

After 9 months abundant conidia.

Both hyphae and conidia dikaryotic.

Ref.: Buchalo (1988), Buchalo et al. (1971), Hashioka and Arita (1978), Hübsch (1978), Käärik (1965), Kühner (1946), Lyr (1958), Mišurcová et al. (1987), Watling (1983).

Pholiota squarroso-adiposa Lange

The culture grows well (colony diameter 80 mm after 15 days). The growth does not change the colour of the medium. Aerial mycelium finely filamentous, in places subtly flocculose. Profile flat. Colony margin delineated, finely woolly, colour white, turning yellow on ageing. Odour pleasant, yellowish guttation appears after 3 weeks in the region of the inoculum.

Aerial hyphae thin-walled, 2-3 µm diam. Clamp connections frequent, on almost every septum. Anastomoses observed, lateral hyphae originate at the site of the septum as well as in other places, most often at a 90° angle. Aerial mycelium rarely features club-like allocysts 7x12 µm.

The occurrence of cylindrical to bullet-shaped conidia 5x12 µm observed after 9 months (Fig. 3).

Hyphae dikaryotic, allocysts and conidia also dikaryotic.

Ref.: Hübsch (1978).

Kuehneromyces mutabilis (Scheff.: Fr.) Sing. et Smith

Syn.: **Pholiota mutabilis** (Fr.) Kumm.

The culture grows well (colony diameter 80 mm after 16 days). The growth does not alter the colour of the medium. Aerial mycelium sparsely velvety with suggestion of radial filaments. Advancing zones regular and about 0,7 mm wide. Profile flat. Colony margin even, demarcated, very finely woolly. Colour white. Odour inconspicuous, guttation not observed. A one-year incubation in a refrigerator on malt agar yielded moderately developed primordia.

Aerial hyphae thin-walled, 1.3x4.2 µm diam. Clamp conections frequent, septa without clamps also relatively frequent. Anastomoses very frequent, branching very rare. Anamorphs not observed.

A 9-month old culture without change.

Hyphae dikaryotic.

Ref.: Boidin (1959), Bresinski and Besl (1979), Buchalo (1988),

Table 1: Results of enzymatic activities

	Pholiota adiposa	Ph. alnicola	Ph. carbonaria I	II	II	Ph. conifera	Ph. destruens	Ph. flammans	Ph. flavida I	II	Ph. gummosa I	II	Ph. jahnii	Ph. lenta	Ph. lucifera	Ph. spumosa	Ph. squarrosa I	II	Ph. squarroso-adiposa	Kuehneromyces mutabilis
laccase	++	++	+	+	++	+	-	+	+++	++	+++	+++	+++	+	+++	++	++	++	++	+++
catalase	+	+	+	+	+	+	++	+	+	+	+	+	+	+	+	+	+	+	+	+
peroxidase	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
tyrosinase	+++	-	-	-	-	+++	+++	-	+	+	+	+	+	+	-	+	++	++	++	+
lipase	-	-	+	+	+	-	+	-	-	-	-	-	+	+	++	+	-	-	+	+
lecithinase^x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	-
amylase	+	+	++	++	++	++	-	+	++	++	++	++	+++	++	+	++	-	-	-	+
cellulase	+	+	+	+	+	+	+	+	+	+	±	±	+	+	+	+	±	+	+	+
β - galactosidase^x	-	-	-	-	-	+	-	-	+	+	-	-	-	+	-	+	-	-	-	-
α - glucosidase^x	-	-	-	-	-	-	-	-	+	+	-	-	-	+	-	+	-	-	-	+
proteases - gelatinase	+	-	-	-	-	+	-	-	-	-	-	+	+	+	+	+	-	+	-	-
- milk peptidase	+	-	+	+	±	+	+	-	+	+	+	+	+	+	+	±	+	+	+	-
milk clotting enzymes	+++	-	+	+	+	+	-	+	-	-	+	+	+++	++	+	±	++	+	+	-
urease	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	-	+	-	-

Explanatory notes to Table 1. - no activity, ± disputable activity, + - +++ semiquantitative demonstration of activities;
x activities very weak

Buchalo et al. (1971), Käärik (1965), Kühner (1946), Lyr (1958), Mišurcová et al. (1987), Semerdžieva (1965).

KEY FOR DETERMINATION OF SPECIES OF THE GENUS PHOLIOTA ACCORDING TO MORPHOLOGICAL AND BIOCHEMICAL CHARACTERISTICS OF MYCELIAL CULTURES

1a. amylase positive 2

2a. tyrosinase positive 3

3a. peroxidase positive .... Pholiota spumosa

3b. peroxidase negative 4

4a. urease positive .... Ph. lenta

4b. urease negative 5

5a. growth rate more than 90 mm in 24 days 6

6a. conidia or aleurospores present 7

7a. aleurospores present after 21 day cultivation, cellulase activity very weak .... Ph. gummosa

7b. aleurospores absent after 21 day cultivation, strong cellulase activity 8

8a. positive ß-galactosidase, culture turns yellow .... Ph. adiposa

8b. negative ß-galactosidase, culture does not turn yellow . Ph. conifera

6b. anamorphs absent .... Kuehneromyces mutabilis

5b. growth rate is remarkably slower 9

9a. aleurospores present, lipase negative, the profile of the colony flat .... Ph. flavida

9b. aleurospores absent, lipase positive, the profile of the colony convex .... Ph. jahnii

2b. tyrosinase negative 10

10a. laccase positive 11

11a. growth rate more than 90 mm in 24 days, gelatinase positive .... Ph. squarroso-adiposa

11b. growth rate is remarkably slower, gelatinase negative .... Ph. squarrosa

10b. laccase negative .... Ph. destruens

1b. amylase negative 12

12a. urease positive .... **Ph. lucifera**

12b. urease negative 13

13a. growth rate more than 90 mm in 24 days 14

14a. aleurospores present after 3 month cultivation, milk peptidase positive, fructification very rare .... **Ph. flammans**

14b. aleurospores absent, milk peptidase negative, fructification frequent **Ph. carbonaria**

13b. growth rate remarkably slower .... **Ph. alnicola**

DISCUSSION

Summary treatment of a larger set of species of the genus **Pholiota** has so far been lacking, with literature sources bringing only partial data on individual species. **Pholiota jahnii** has not yet been cultivated. Most of the species were found to have common cultural characters: thin-walled dikaryotic hyphae with anastomoses, positive laccase, catalase, amylase, milk-clotting enzymes, cellulase, milk proteinase and negative peroxidase, urease, lecithinase, α-glucosidase, and ß-galactosidase.

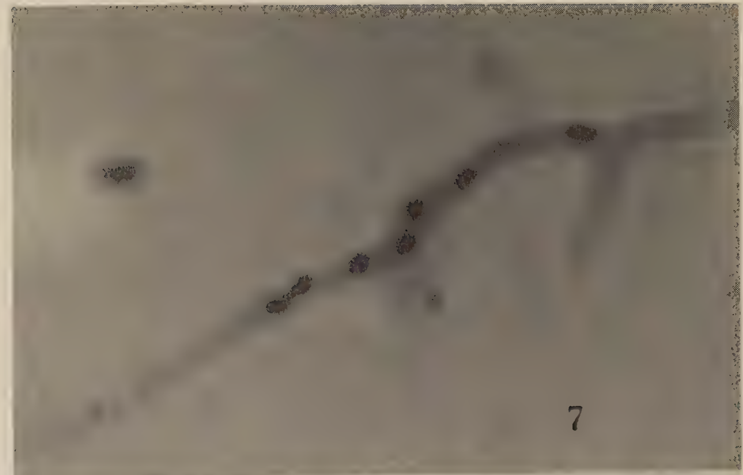
The mat colour and mat texture studied as macroscopic features differed in individual species (see Results). As to the rate of growth, the set can be divided into two more or less homogeneous groups (see growth curves) - species envincing rapid growth on MEA (**Pholiota adiposa, Ph. carbonaria, Ph. conifera, Ph. flammans, Ph. gummosa, Ph. lucifera, Ph. squarroso-adiposa, Kuehneromyces mutabilis**) and species with slow growth (**Ph. alnicola, Ph. destruens, Ph. flavida, Ph. jahnii, Ph. lenta, Ph. spumosa, Ph. squarrosa**).

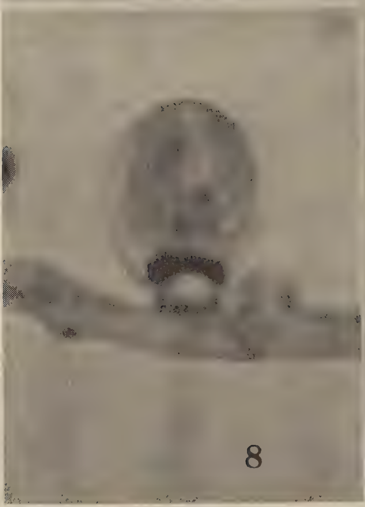
Among microscopic characters a number of authors observed conidia in species **Pholiota adiposa, Ph. conifera, Ph. squarrosa** and **Ph. squarroso-adiposa**, in keeping with our results (e.g. Kühner, 1946; Nobles, 1948, 1965; Semerdžieva, 1965; Arita et al., 1980; Pantidou et al., 1983; Watling, 1983). Hübsch (1978) observed conidia in the **Pholiota adiposa** species in all strains, in the **Ph. squarrosa** species only in three out of six strains, in the **Ph. squarroso-adiposa** species no conidia were observed. We have found that species **Pholiota squarrosa** and **Ph. squarroso-adiposa** form conidia only after a prolonged cultivation. It is therefore necessary to state with individual characteristics also the culture age and cultivation conditions.

Anamorphs or allocysts are produced abundantly when the mycelia are transferred to a fresh medium as when they have been growing for a long time. Aleurospores were observed in species **Pholiota adiposa, Ph. gummosa, Ph. flammans.** In **Pholiota adiposa** our observations of aleurospores were in keeping with the observations of Hübsch (1978) and Arita (1979), in the **Ph. gummosa** species with the data of Hübsch (1978); the same author observed these formations also in **Ph. squarrosa** where we failed to record them. Other authors (Nobles, 1948; Semerdžieva, 1965) did not observe aleurospores in the **Pholiota adiposa** species. According to our observations, the **Pholiota adiposa** species forms aleurospores only after a prolonged cultivation. Allocysts were observed in species **Pholiota alnicola, Ph. lucifera** and **Ph. flavida.** In the **Pholiota alnicola** species our positive observations were in accordance with the data of Kühner (1947), Nobles (1948), and Deneyer (1960). In **Pholiota flavida** Hübsch (1978) termed formations of the same shape and size chlamydospores.

Enzymatic activity. Studies of oxidase in the **Pholiota** genus have been relatively frequent (Boidin, 1951; Lyr, 1958; Käärik, 1965; Nobles, 1965; Koenigs, 1971; Bresinski and Besl, 1979; Marr, 1979). The results of tests of peroxidase, catalase and tyrosinase activity published by other authors are in keeping with our results. Laccase tests of the **Pholiota destruens** species performed with syringaldazine or guiacol were negative; however, the species oxidized within 24 h α-naphtol (guiacol and α-naphtol are low-specificity agents for determination of activity of phenol oxidases which include also laccase). Marr (1979) failed to detect laccase in **Pholiota lenta** by using syringaldazine; however, he worked with fruit-bodies, not with mycelial cultures. Hydrolases have been much less studied. No studies of the genus **Pholiota** have been done with respect to the activity of lecithinase, amylase, α-glucosidase, ß-galactosidase and urease. Nerud et al. (1982) found lipase in **Pholiota adiposa** and **Ph. conifera** species with triolein as substrate. On using Tween 80 and 20 we have detected no lipase in these species. Proteinases and milk clotting enzymes have been more thoroughly studied. Buchalo et al. (1971) found a slight activity during casein decomposition (submerged cultivation) in **Pholiota adiposa** (in our studies milk peptidase likewise positive) and, again similar to our data, a negative proteolytic activity in **Kuehneromyces mutabilis.** In contrast to their findings, however, we found slight peptidase activity in **Pholiota squarrosa** and **Ph. conifera** species. No gelatinase was detected in **Pholiota squarrosa.** Similar to Mišurcová et al. (1978) we have found activity of milk clotting enzymes in **Pholiota adiposa,** but in contrast to these authors also in **Ph. squarrosa** while it was absent in **Kuehneromyces mutabilis.**

The culture of the **Kuehneromyces mutabilis** species, which is related to the genus **Pholiota,** did not differ appreciably from cultures of **Pholiota** either morphologically or biochemically.





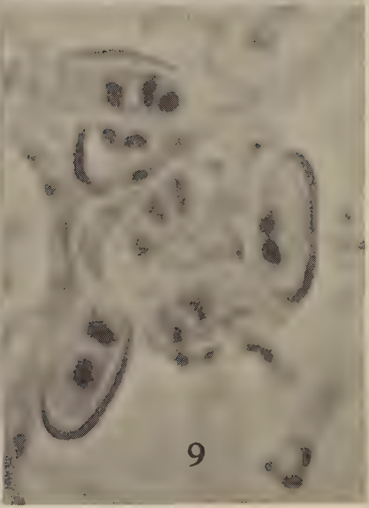


Fig. 7. **Pholiota gummosa.** A position of a multinucleate tip cell with the nonseptate clamp owing to lack of septal formation as well as repeated division of nuclei Fig. 8. **Pholiota gummosa.** Aleurospore with two homologous nuclei. Fig. 9. **Pholiota adiposa.** Conidia. Each cell of contains two nucleus or three homologous nuclei.

Our results made it possible to select characters for determination of species in mycelial culture. These include growth rate, formation of anamorphs, production of tyrosinase, laccase, amylase, urease and peroxidase. Other, less distinct markers in which the species differed often only quantitatively, were used as auxiliary, mostly in combinations.

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TWO NEW *GLOMUS* SPECIES FROM ARABLE LAND

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SUMMARY

The vesicular-arbuscular mycorrhizal fungi *Glomus fistulosum* and *Glomus fragilistratum* are described. The former is characterized by a fistular laminated wall, the latter by a unit wall which breaks into flakes and strips when spores are broken.

INTRODUCTION

Investigations into the ecology and agronomic importance of vesicular-arbuscular mycorrhizal (VAM) fungi in cultivated soils have been carried out in Denmark for several years (cf. *e.g.* Jensen & Jakobsen, 1980; Jakobsen & Nielsen, 1983; Jakobsen, 1986). A number of VAM fungi were collected. *Glomus mosseae* (Nicol. & Gerd.) Gerd. & Trappe predominated in five soils and *G. caledonium* (Nicol. & Gerd.) Trappe & Gerd. in one. Further, one sixth of the spores isolated from one soil were identified as *Gigaspora calospora* (Nicol. & Gerd.) Gerd. & Trappe (syn. of *Scutellospora calospora* (Nicol. & Gerd.) Walker & Sanders). Some isolates (Jensen & Jakobsen, 1980) were regarded as new species, and two of these are described in this paper.

MATERIALS AND METHODS

Isolates of VAM fungi were collected in 1978 at Askov, southern Jutland, at Hillerslev, northern Jutland, and at Jullerup, Funen, Denmark. The fungi, taken from soil suspensions, initially were propagated on white clover (*Trifolium repens* L.). Similar-looking spores then were selected and reinoculated on maize (*Zea mays* L.). Homogeneous cultures were obtained by five repeats of this procedure.

The spores were examined in several different mountants: PVLG using the recipe of Omar, Bolland & Heather (1979), and prepared according to the method of Koske & Tessier (1983); Shear's mounting fluid (2% CH_3COOK in 0.2M pH 8 McIlvaine's buffer: glycerol: ethanol (95%) in a 5:2:3 proportion; Punithalingam, 1971); 3% KOH for clearing (cf. *e.g.* Baral, 1987); 1M sucrose (osmoticum; cf. *e.g.* Villanueva, 1966), or Melzer's reagent.

Identification of the isolates were based mainly on the INVAM species guide (Schenck & Pérez, 1988) and by consideration of details discussed by Morton (1988). For each species, spore size was based on more than 200 measurements made with an ocular screw micrometer.

RESULTS

Glomus fistulosum Skou & Jakobsen sp. nov.

Etymology: The Latin epithet '*fistulosum*' means fistular and refers to the pronounced fistular laminated wall of the spores.

Descriptio: *Sporocarpia ignota. Sporae in terra singulatim efformatae, luteae, globosae, 78 - 137 - 200 µm magnae, inter quas 11 pro 100 late ellipsoideae vel pyriformes, 67 - 121 - 166 x 94 - 138 - 178 µm magnae. Sporae complexis tunicis, 5.5 - 8.9 - 13 µm crassae, quinque stratis (1-5) instructae, in duo turmis (A-B) formatae. Stratum externum evanescens et stratum unitum (sequens), haec duo strata adherentia, tenuibus, non plus quam 1 a 2 µm, et hyalina. Stratum tertium laminatum, luteum, variabiliter crassum, fistulas habens, quo aditus tenuiter declivis ad aperturam angustam, quae plerumque 0.5 µm. Strata membranacea duabus in turma B, hyalina, non plus quam 1 a 2 µm crassa. Hyphae affixae, hyalinae, non occlusae, non septatae, 6-10 µm crassae ad basim sporae pariete 2.7 µm plerumque. Mycorrhizas vesicular-arbusculares formans.*

Habitat in terra ad Askov et Hillerslev, Jutlandia, Dania.

Holotypus increvit ad Zea mays L. anno 1989, in Museo et Herbario Hauniensi (C), Dania depositus. Isotypus aeque ac cultura ad INVAM Universitas Florida, Gainesville, U.S.A. depositus.

Description: Sporocarps unknown. Spores formed singly in soil, pale yellow and yellow in reflected and transmitted light, respectively, globose, 78 - 137 - 200 µm diam. with 86% between 120 and 160 µm; 11% broadly ellipsoid or pyriform, 67 - 121 - 166 x 94 - 138 - 178 µm diam. The spore wall consists of five walls in two groups, with composite wall 5.5 - 8.9 - 13 µm thick (Fig. 1).

WALL GROUP A consists of three walls. Outermost, two thin, hyaline, adhering walls, each not more than 1-2 µm. Wall 1 is evanescent and wall 2 is a rigid unit wall (Fig. 2g). Wall 3 is a yellow, laminated and fistular wall which increases in thickness and number of laminar fissures with spore age (Fig. 2a-i). The openings of the fistules in wall 3 gently slope into an aperture of 0.5 µm on an average (Fig. 2h, i). The fistules appear as points at the focal plane. As the focus is lowered, the fistules incline and appear as diffuse radial lines until they are in horizontal position and clearly visible. This characteristic appearance results from the degrees of inclination of the fistules across the spores as they are seen in the microscope.

The laminated wall 3 breaks rather easily along the laminar fissures. The fractures take on a denticular appearance at the broken edge of this wall, and thus considered ornamented (Fig. 2i).

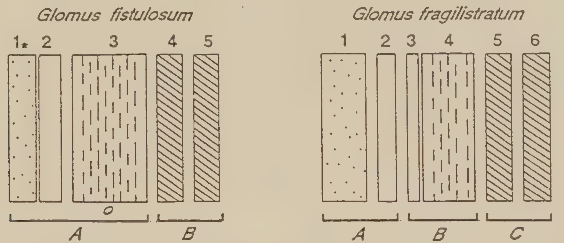


Figure 1. Murographs of the spore wall structure of *G. fistulosum* and *G. fragilistratum*. Muronyms are $A(E_*UL_o)$, B(MM), and A(EU), B(UL), C(MM), respectively.

WALL GROUP B consists of two thin, hyaline membranaceous walls, each not more than 1-2 µm thick. The innermost wall 5 is most easily seen when the cell contents contract on plasmolysis in 1M sucrose (Fig. 2a, e).

A subtending hypha appears to be inserted in the spore walls. It is 6-10 µm wide at the spore base. Hyphal walls are hyaline and with an averaged thickness of 2.7 µm. The pore in the subtending hyphae is open without occlusion or septum (Fig. 2a, b). Spore contents are colourless and appears as variable-sized globules.

G. fistulosum forms vesicular-arbuscular mycorrhizas on several cultivated plants.

Distribution. *Glomus fistulosum* was collected in two habitats by I. Jakobsen in July 1978. Isolate No. 21 was collected in a crop of winter wheat (*Triticum aestivum* L.) on a long-term experimental field with sandy loam at Askov (Askov lermark) in southern Jutland, Denmark. Isolate No. 22 was collected in a crop of spring barley (*Hordeum vulgare* L.) on a loamy soil at Hillerslev in northern Jutland, Denmark (cf. Jensen & Jakobsen, 1980).

Mycorrhizal associations. *G. fistulosum* was collected under conditions that suggest associations with wheat and barley in the field. Further, the fungus (Nos 21 and 22) formed VA mycorrhizas in pot cultures with leek (*Allium porrum* L.), maize (*Zea mays* L.), and white clover (*Trifolium repens* L.).

Types. For purification of *G. fistulosum* (Nos 21 and 22), ten alike spores were separated under the microscope and added to pre-sterilized soil seeded with maize in pot cultures. The holotype (No. 21) was selected in 1989 after five repeats of this procedure and deposited at the Botanical Museum and Herbarium, Copenhagen, Denmark (C). The isotype and a living culture from No. 21 are deposited at the International Culture Collection of VA Mycorrhizal Fungi (INVAM), University of Florida, Gainesville, U.S.A.

Glomus fragilistratum Skou & Jakobsen sp. nov.

Etymology: The Latin epithet, '*fragilistratum*' from *fragilis* = fragile, easily shattered, and *stratum* = layer, refers to the third spore wall which is characteristically fragile.

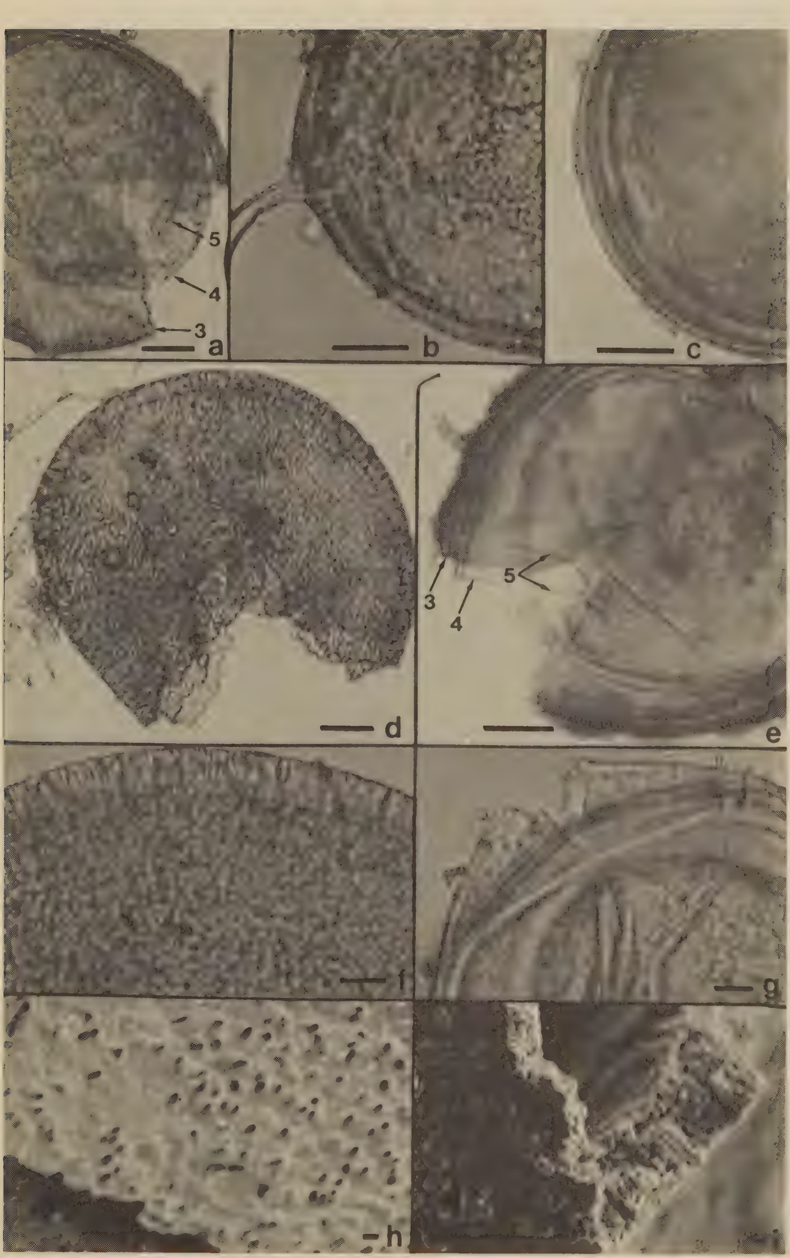
Descriptio: *Sporocarpia ignota. Sporae in terra singulatim efformatae, luteae vel pallide aurantiacae, globosae, 108 - 146 - 191 µm magnae inter quas 18 pro 100 late ellipsoideae vel irregulares, 108 - 142 - 181 x 121 - 169 - 231 µm magnae. Sporae complexis tunicis, 7 - 9 - 12 µm crassae, sex stratis (1-6) instructae, in tres turmis (A-C) formatae. Stratum externum hyalinum, gelatinosum cum granulis, et evanescens, variabiliter crassum attingentia 4.5 µm. Stratum secundum unitum, hyalinum, rigidum, 1.4-3.0 µm. Stratum tertium item unitum, hyalinum, vitri instar, in rimis et vittatis fragilibus, ca. 1 µm crassum, plus minusve ad stratum laminatum adhaerens. Stratum quartum luteum vel pallide aurantiacum, laminatum, variabiliter crassum, plerumque 5.1 µm. Stratum quintum hyalinum, membranaceum, leniter alveolatum, non plus quam 1 µm et stratum sextum hyalinum, membranaceum et granulatum, non plus quam 1 µm. Stratum primum usque ad quartum declive ad hyphas affixas, quae habentes diametrum 9-15 µm ad basim sporarum. Mycorrhizas vesicular-arbusculares formans.*

Habitat in terra ad Jullerup, Fionia, Dania.

Holotypus increvit ad Zea mays L. anno 1989, in Museo et Herbario Hauniensi (C), Dania depositus. Isotypus aeque ac cultura ad INVAM Universitas Florida, Gainesville, U.S.A. depositus.

Description: Sporocarps unknown. Spores formed singly in soil, yellow and bright yellow or pale orange in reflected and transmitted light, respectively, globose, 108 - 146 -

Figure 2. *Glomus fistulosum.* **a**. Broken spore in 1M sucrose. Arrows indicate the laminated wall (3) and the two innermost walls (4 and 5). Note the subtending hypha with the open pore. x 300, bar 25 µm. **b**. Spore showing the open pore to the subtending hypha. The fistules appear as radial stripes on the laminated wall. In PVLG. x 425, bar 25 µm. **c**. The laminated wall with radial lines of the fistules. In PVLG. x 425, bar 25 µm. **d**. Broken spore cleared in 3% KOH. The fistules appear as small points on the inside (note the fractures) as well as on the outside, and as radial lines at the spore periphery. x 300, bar 25 µm. **e**. Broken spore. Arrows point to the laminated wall 3 and the two innermost walls (4 and 5). In PVLG. x 400, bar 25 µm. **f**. Cross section of the fistular, laminated wall in 3% KOH. x 650, bar 10 µm. **g**. Spore in 3% KOH with the outer, hyaline walls (1 and 2) broken. x 550, bar 10 µm. **h**. SEM micrograph of the surface of the laminated wall with fistule openings. x 2500, bar 1 µm. **i**. SEM micrograph of fractures of the laminated wall with the fistules in longitudinal section. x 2500, bar 1 µm.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191 µm diam. with 84.5% between 120 and 170 µm; 18% broadly ellipsoid or irregular, 108 - 142 - 181 x 121 - 169 - 231 µm diam. The spore wall consists of six walls in three groups (A-C), with the composite wall 7 - 9 - 12 µm thick (Fig. 3).

WALL GROUP A consists of two walls. Wall 1 is gelatinous, hyaline and evanescent. It may have a gritty content that is most easily seen in Melzer's reagent. When present, this wall may be up to 4.5 µm thick (Fig. 3a-c). Wall 2 is a rigid, hyaline unit wall, 1.4-3.0 µm thick (Fig. 3e, h, i).

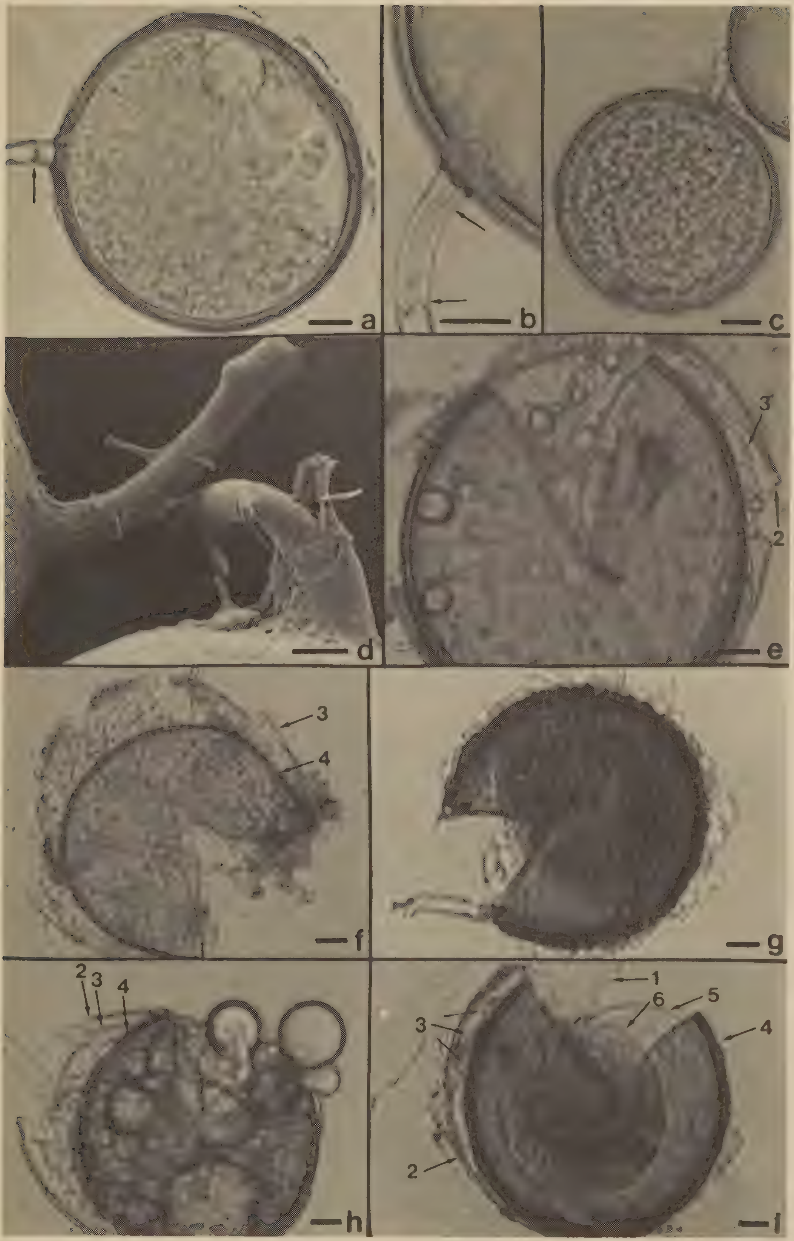
WALL GROUP B consists of two walls (3 and 4). Wall 3 a vitreous hyaline unit wall which rarely exceeds 1 µm on thickness. It breaks into flakes and strips on broken spores. Cracks radiate from the point where the spores are broken with a tapering instrument. This wall sometimes is adherent to the laminated wall (Fig. 3e-i). Wall 4 is a yellow or pale orange laminated wall of varying thickness, 5.1 µm on an average. This wall becomes reddish-brown in Melzer's reagent (Fig. 3a-i).

WALL GROUP C consists of two hyaline membranaceous walls, neither more than 1-2 µm thick. Wall 5 is weakly alveolate and the innermost wall 6 appears granular. The latter wall is most clearly visible when the cell contents contract on plasmolysis (Fig. 3h, i). The spore content consists of differently sized oil globules that become viscid with age (Fig. 3h).

Walls 1-4 extend as walls of the subtending hyphae (Fig. 3d) for a short distance and then tapes off (Fig. 3a, b). Diameter of subtending hyphae at the spore base is 9-15 µm, usually with 1-2 hyphal septa positioned close to the spore. Occasionally, the hypha has an angular bend between the first and the second septum, and narrow branch hyphae may occur at this region (Fig. 3a, b, d).

G. fragilistratum forms vesicular-arbuscular mycorrhiza on several cultivated plants.

Figure 3. *Glomus fragilistratum*. **a.** Spore with subtending hypha and remains of the exterior, gelatinous, hyaline wall. Arrow points to a hyphal septum. x 250, bar 25 µm. **b.** Part of spore with subtending hypha. Arrows point to hyphal septa. Note the thick hyphal wall due to the extension of the four outer walls of the spore. x 400, bar 25 µm. **c.** Spore with the exterior, gelatinous, hyaline wall. x 225, bar 25 µm. **d.** SEM micrograph of subtending hyphae. Note the continuation of spore outer walls onto hypha. x 800, bar 10 µm. **e.** Broken spore showing two outer rigid, hyaline unit walls. Wall 3 is broken into radiating sections. x 225, bar 25 µm. **f.** Crushed spore more clearly showing the separation of the third wall in to radial segments. x 175, bar 25 µm. **g.** Hyaline flakes broken off the third wall of a spore in Melzer's reagent. x 225, bar 25 µm. **h.** Broken spore with wall 2-4 and the oily to viscid content visible. x 175, bar 25 µm. **i.** Broken spore with all six wall layers visible. x 175, bar 25 µm. **a-c**, **e** and **f** in PVLG; **h** and **i** in 1M sucrose.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Distribution. *Glomus fragilistratum* was collected by I. Jakobsen after harvest in July 1978. The fungus (isolate No. 33) was collected in a crop of spring barley (*Hordeum vulgare* L.) on sandy loam at Jullerup (Statens gård), Funen, Denmark (cf. Jensen & Jakobsen, 1980).

Mycorrhizal associations. *G. fragilistratum* was collected under conditions that suggest association with barley in the field. Further, the fungus (No. 33) formed mycorrhizas in pot cultures with leek (*Allium porrum* L.), maize (*Zea mays* L.), and white clover (*Trifolium repens* L.). Inoculation with this fungus improved uptake of phosphorus (P) and growth of barley, maize, and white clover in P-deficient irradiated soils (Jakobsen, unpublished).

Types. After five inoculations on maize in pot cultures, the holotype of *G. fragilistratum* (No. 33) was selected in 1989 and deposited at the Botanical Museum and Herbarium, Copenhagen, Denmark (C).

Isotype and a living culture from No. 33 are deposited at the International Culture Collection of VA Mycorrhizal Fungi (INVAM), University of Florida, Gainesville, U.S.A.

DISCUSSION

We have used the conventional wall-grouping (Walker, 1983) though in reality only the two outermost walls of spores in *G. fistulosum* may be difficult to separate, and as flakes or segments of the vitreous wall 3 may occasionally adhere to the laminated fourth wall of the spores in *G. fragilistratum*.

The spores of *G. fistulosum* and *G. fragilistratum* have more complex wall structures than those of other described *Glomus* species. The five-walled spores of *G. gerdemannii* Rose, Daniels & Trappe is closest in wall complexity, but the sequence of wall types, hyphal attachment, and spore size are different (Rose et al., 1979).

The fistular or pored structure of the laminated wall in spores of *G. fistulosum* is unique. The narrow (about 0.5 µm), fistules pass through the laminar fissures. They are uniformly distributed over the spore wall and are confined to the laminated wall. For this reason, the fistules are not considered artifacts caused by bacterial or fungal activities.

The vitreous unit wall (wall 3) in spores of *G. fragilistratum* is diagnostic for this species and does not compare to any other wall in described *Glomus* species. It is visible, however, only when spores are broken with a pointing instrument. It does not flake as Rose et al. (1979) report for the outermost walls of *G. gerdemannii*.

The outer evanescent, gelatinous wall is clearly thicker on spores of *G. fragilistratum* than on those of *G. fistulosum*. This wall resembles the outer wall of *G. clarum* Nicol. & Schenck (Nicolson & Schenck, 1979), *G. manihotis* Howeler, Sieverding & Schenck (Schenck, Spain, Sieverding

& Howeler, 1984), and probably *G. intraradices* Schenck & Smith (Schenck & Smith, 1982).

The unit wall 2 of both species is hyaline and rigid rather than gelatinous. Therefore, this wall cannot be just a second layer of the outer wall.

The presence of two inner membranaceous walls in spores of *G. fistulosum* and *G. fragilistratum* is unique for *Glomus* species described to date. This wall structure suggests a phylogenetic relationship with members of *Acaulospora* (J.B. Morton, pers. comm.).

Walls 1-4 of *G. fragilistratum* spores extend on or past the closing septum in the subtending hyphae. In that respect, they resemble several other *Glomus* species such as *G. clarum* (Nicolson & Schenck, 1979) and *G. mosseae* (Nicol. & Gerd.) Gerd. & Trappe (Nicolson & Gerdemann, 1968).

Globular to pear-shaped, thin-walled, hyaline, vesicle-like cells, 8-15 µm in diameter, occur scattered on the mycelium of *G. fistulosum* between soil particles. Their function, if any, is unknown.

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THE GENUS PEZIZELLA I.: NOMENCLATURE AND HISTORY.

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Summary

The nomenclature and the history of the exploration of the genus ***Pezizella*** *Fuckel and of genera connected with it (****Allophylaria*** *Karst.,* ***Calycina*** *(Nees) Gray,* ***Cystopezizella*** *Svr.,* ***Eubelonis*** *Clem.,* ***Eubelonis*** *Höhnel,* ***Pezizella*** *subgenus* ***Ctenoscypha*** *Starb., and* ***Pseudohelotium*** *Fuckel) are discussed. The "typus generis" of* ***Pezizella*** *is* ***P. sordida*** *(Fuckel) Fuckel. In this connection some systematic consequences are pointed out.* ***Eubelonis*** *Clem. is a synonym of* ***Pezizella*** *but neither* ***Allophylaria*** *nor* ***Calycina*** *is. The supposed synonymy of* ***Peziza sordida*** *Fuckel with* ***Peziza avellanae*** *Lasch and* ***Peziza vulgaris*** *Fr. is discussed. The typification of* ***Calycina*** *with* ***Peziza herbarum*** *Pers. is dubious.*

> Natürlich System, ein widersprechender Ausdruck. Die Natur hat kein System, sie hat, sie ist Leben und Folge aus einem unbekannten Zentrum, zu einer nicht erkennbaren Grenze. Naturbetrachtung ist daher endlos, man mag ins einzelnste teilend verfahren oder im ganzen nach Breite und Höhe die Spur verfolgen.
>
> Goethe, Probleme

I. Introduction

In the present work I want to try to represent the history of the exploration and the nomenclature of the genus **Pezizella** (Ascomycetes, Leotiales) and of some further genera, which in this connection are of special interest. If this is perhaps done in more detail than necessary, I take the following considerations as a basis for the style of presentation:

Firstly: I want to point out troubles which arise by treating these organisms - many of which are smaller than 0.5 mm in diameter - and which are exclusively caused by nomenclatural problems of this order.

Secondly: The more detailed representation should increase the legibility of a subject, which generally is looked at as dry as dust and scarcely readable.

The interest in these organisms is no child of our time, but already our forefathers struggled with them more than 200 years ago. First of all they used their eyes for their examinations or, to enhance their efficiency, a hand-lens, and only in rarer cases the compound microscope. But not until the 19th century was the application of this device used regularly. Accordingly the descriptions - usually written in Latin - were limited to such characters as colour, shape, consistency, etc. of the apothecia. Anatomical characters were completely absent or were only considered insufficiently.

Many species, the names of which we still use today, were named by the originators of systematic mycology, e.g., ALBERTINI and SCHWEINITZ, BATSCH, FRIES, NEES von ESENBECK, PERSOON, to mention only some of them. The present use of these names is not arbitrarily, but is governed by definite rules, which are laid down in the ICBN. This "law" shall contribute to the nomenclatural stability, if it is obeyed. Often an inconsiderable sacrifice of time is necessary to find a reliable nomenclatural basis for the species and genera, before the "true" work can start.

This working method reminds us of a criminologist's or a historian's work, rather than of the work of a biologist, who is supposed to use modern and promising methods, as usually employed, e.g., in molecular biology or gene technology. This "screening" of old names is by no means an end in itself: at the same time the name of any taxon is its "address," where all characters and qualities are filed, and, what is much more important, can be found again; it serves for storing information (data).

In the herbaria of many authors we often find specimens to which the names are tied ("Datenträger"), so that we have the possibilty to study many of those old species with a multitude of modern methods. The "finger-print", however, which is obtained by such studies, is sufficient to identify species, which have been found today, even if in some cases doubts can remain . The working up, i.e., the check up of the "old" species, has still not been completed to this day. Nevertheless again and again species or genera are pushed to and fro in the system according to descriptions which frequently do not meet the minimal demand, which we need for the systematic evaluations, or species and genera are sometimes described far too thoughtlessly.

As long as this "homework" has not been finished to a greater extent than till now, there can scarcely be nomenclatural stability and a reliable natural system, what ever we may understand by it for the fungi, for the at present third-largest order of the Ascomycetes.

Consequently at the moment it is only possible to deduce

ERRATA, VOLUME THIRTY-SIX

Page	284	line	16	*for*	arbitrarily	*read*	arbitrary
			34	*for*	possibilty	*read*	possibility

reliable information, such as distribution of species and genera, interdependences of substrata or further ecological data, the occurence of secondary metabolic products, as far as these are known at all, with great reservation, quite apart from such "simple" jobs as determination of the families, genera and species, which often reveal inconsistencies and absurdities within this system.

These comments do not imply that the application of biochemical and physiological methods in taxonomy and systematics is useless, but only that these have no sound basis as long as the "classical" ones have led to stable opinions.

If it is right that the quality of a system reflects the acquaintanceship with a group of organisms, then we do not know - nearly at the end of the 20th century - very much more about the Leotiales than REHM had at its beginning.

II. The typification of the genus Pezizella

FUCKEL (1870 p. 299) (1) founded the genus **Pezizella** with the following diagnosis:
"Cupulae gregariae, minutae, ceraceae, subdiaphanae, apertae, stipitatae, totae glabrae: Discus subhemisphaericus. Asci elongati, oblongi, linearsve, 8spori. Sporidia cylindracea, oblongave (?), plerumque curvata, continua, hyalina: Paraphyses simplices, filiformes". In his genus he placed six species in the order listed below:

1. **Pezizella avellanae** (Lasch) Fuckel
2. " **sordida** (Fuckel) Fuckel
3. " **pulchella** (Fuckel) Fuckel
4. " **juncina** (Pers.) Fuckel
5. " **rubella** (Pers.) Fuckel
6. " **dilutella** (Fr.) Fuckel

Over the period of its more than one hundred-year-old history more than 400 (2) species have been added to this genus till today. FUCKEL, as was the custom in the last century, did not designate a "typus generis." For that reason the few or insignificant microscopic characters had inevitably to lead to different interpretations of the genus by subsequent mycologists, as far as they accept **Pezizella** at all; for the majority of the mycologists of the late 19th century did not use it at all (3) or only as a subgenus (4). SACCARDO (1889), a few others (5), and REHM (1892) made use of FUCKEL's generic name. Both, SACCARDO and REHM described FUCKEL's genus as having sessile apothecia, which was emphasized by both authors: SACCARDO, l.c. p. 276: "Est **Phialea** sessilis v. **Mollisia** laeticolor..." and REHM, l.c. p. 653: "Diese Gattung umfaßt eine große Anzahl zumeist winziger Arten mit sitzenden Apothecien...". The two authors did not designate a type species, either. REHM (l.c.) did not even retain **any** of the "foundation species" in **his** genus Pezizella (6) , whereas SACCARDO (l.c.) retained at least **P. juncina** and **P. dilutella**.

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(1) Concerning the publication date of FUCKEL's opus cf. ROGERS (1954) and STAFLEU & COWAN (1976).

(2) About one quarter (107) of the "species" were exclusively described by VELENOVSKÝ (1934, 1939, 1947), who even founded a family on this name: "12. Fam. **Pezizellaceae**" (1934, p. 154). Unfortunately I had not the privilege to study any of VELENOVSKÝ's species. Within the **Leotiales** (CARPENTER 1988 = **Hymenoscyphales** nom. nud. BELLEMÈRE (1978) = **Helotiales** auct.) this number is only exceeded in the genus **Hymenoscyphus** with more than 560 "species."

Only in the 20th century a typification was made and that just four times, although CANNON et al. (1985) stated: "Typus: Not designated.", a statement which is only right if it refers to the original author:

1. BACHMAN (1909): **Pezizella sordida** (Fuckel) Fuckel
2. v. HÖHNEL (1926): **Pezizella avellanae** (Lasch) Fuckel
3. CLEMENTS & SHEAR (1931): **Pezizella granulosella** (Karst.) Rehm
4. SVRČEK (1983): **Pezizella pulchella** (Fuckel) Fuckel

Let us have a close look at these typifications in their chronological order and then analyze the results referring to their nomenclatural significance.

BACHMAN (1909 p. 55) wrote - without going into detail: "Type species, **Pezizella sordida** Fuckel." In the diagnosis of the genus she also described the apothecia as "sessile," surely influenced by REHM's flora.

v. HÖHNEL (1926) designated **P. avellanae** (Lasch) Fuckel as the type specimen ("Gründungsart"), without adequate reasons, too. From his publication about fungi it can be shown that he used the obsolete "first species rule" for his typifications: "Als erste, also Typusart, erscheint der Name Naevia scripta Fr." (1917, p. 300) (7).

CLEMENTS & SHEAR (1931) selected **P. granulosella** (Karst.)

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(3) E.g. KARSTEN (1871, 1885), BRESADOLA (1881), PATOUILLARD (1883), BOUDIER (1885), QUELET (1886), GILLET (1887), PHILLIPS (1887) and MASSEE (1895).

(4) SCHROETER (1893), LINDAU (1894).

(5) HAZSLINSKY (1886) and FELTGEN (1899 ff) mentioned species of **Pezizella** in their floras, too; as did BOMMER & ROUSSEAU (1890); but these two also characterized the apothecia as "sessile ou subsessile".

(6) As REHM placed all of the original species of **Pezizella** elsewhere, he founded a later homonym (cf. also v. HÖHNEL 1926). In other words this was already emphasized by STARBÄCK (1895, p. 28): "... die von Fuckel (Symb. p. 299) aufgestellt wurde, jetzt aber von REHM ganz anders begrenzt wird,..." Though also VELENOVSKÝ (1934) did not retain any of the original species in his treatment of **Pezizella**, nevertheless he did not create a second homonym, because he only dealt with **P. juncina, rubella** and **pulchella** in his opus.

(7) Cf. also NANNFELDT (1932, p. 7).

ERRATA, VOLUME THIRTY-SIX

Page	284	line	16	*for*	arbitrarily	*read*	arbitrary
			34	*for*	possibilty	*read*	possibility
	287		9	*for*	death 1915.	*read*	death in 1915.
			32	*for*	typification	*read*	typifications
	288		10	*for*	doubts	*read*	doubt

Rehm as the type species, which, however, was not among the six original species. Probably with their choice they intended to contribute to stability and uniformity in using the names of genera, as they also emphasized in the preface of their opus. (8) I presume, they took REHM's influential publications as a basis for their typification, for he was the most recognised and appreciated discomycete scientist world-wide until his death 1915.

According to SVRČEK's (1983) considerations, "Fuckel's **Pezizella pulchella** is the only one species agreeing perfectly with all essential features in the original generic diagnosis." (l.c. p. 68), for "**Pezizella avellanae** (Lasch) Fuckel and **P. sordida** Fuckel are identical with **P. vulgaris** (Fr.) Höhnel and the last three belong to other genera (**P. juncina** (Pers.) Fuckel, **P. rubella** (Pers.) Fuckel, **P. dilutella** (Fr.) Fuckel)" (l.c. p. 68).

Thus we have four typifications with four different lectotype species:
1. **P. sordida** (Fuckel) Fuckel
2. **P. avellanae** (Lasch) Höhnel
3. **P. granulosella** (Karst.) Rehm and
4. **P. pulchella** (Fuckel) Fuckel,

but only **one** of these can represent the genuine type or, none of the four, conceivably, typifies the genus.

In compliance with the rules of the ICBN the "typus generis" has to be selected from among the six species which FUCKEL assigned to his genus, so that CLEMENTS & SHEAR's typification is invalid. V. HÖHNEL's choice has to be excluded, too, because it resulted from the "first species rule" and BACHMAN's typification antedates it by 17 years. Hence BACHMAN's and SVRČEK's typification remain to be considered.

On the strength of nomenclatural considerations there is nothing to argue against BACHMAN's choice, even if it was made without advancing arguments:
1. **P. sordida** belongs among the six original species of the genus.
2. The description of the genus, which is based rather on physical habits and gross morphology, is ± compatible with **P. sordida**, at least grave contradictions do not arise.
3. The type was distributed by FUCKEL in his Fungi rhenani # 2078, thus the species is easily available.

Consequently her typification is the first one which corresponds with the rules of the ICBN. According to Art. 8.1 it is obeyed and the use of the name **Pezizella** can only be annulled by conservation (Art. 14) or rejection (Art. 69) or "if (b) it can be shown that it is in serious conflict with the protologue and another element is available which is not in conflict with the protologue" (ICBN 1988, Art. 8.1, p. 11).

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(8) "...This in many cases necessitates the choice of a species not (underlined by the author) included by the original author of the genus." (l.c., p. 15). This typification corresponds to the use of the name by REHM and other mycologists following him, but it contradicts the rules of the ICBN.

Only in the latter case SVRČEKS' s typification has not to be rejected. Then, however, **Pezizella** becomes a synonym of **Cistella** (= **Clavidisculum**), **Lachnum** (= **Dasyscyphus**), respectively; for the study of a syntype specimen of **P. pulchella** (Fuckel) Fuckel proved without doubts its identity with **Cistella acuum** (Alb. & Schw.) Raitv. (= **Dasyscyphus acuum** (Alb. & Schw.) Sacc. (Cf. also ARENDHOLZ & RAITVIIR 1988). In each case the nomenclatural problem of "PEZIZELLA" is solved in any event: since BACHMAN's typification cannot be ignored, we can say with v. HÖHNEL (1926): "Es steht nun fest, was Fuckel unter Pezizella verstand."

III. Allophylaria - a Synonym of Pezizella or vice versa?

NANNFELDT (1932), too, dealt with the **Pezizella** problem thoroughly and concluded: "Es scheint mir, als ob der Standpunkt v. Höhnels, **P. vulgaris** (9) als Typusart einer emendierten Gattung zu betrachten, nicht zweckmäßig sei: Eine Stütze seiner Ansicht ist auch nicht vorhanden. Es dürfte zweifellos das Richtigste sein, den ein Jahr jüngeren Namen, **Allophylaria**, beizubehalten, mit dem ihr Auctor es verstanden hat, eine höchst natürliche Einheit zu umgrenzen und zu beschreiben" (l.c. p. 290).

His argumentation is not absolutely reasonable (what is the meaning of: "nicht zweckmäßig" ?) and contradictory: on the one hand he rejected the typification and emendation with **P. avellanae** with scarcely convincing arguments on the other hand he exactly synonymized this genus **Pezizella**, using v.HÖHNEL's typification, with Allophylaria (10) (l.c. p. 289: "Syn. **Pezizella** Fuckel. Symb. Myc. 299 emend. v. Höhnel .... (Pseudotypus: **Peziza avellanae** Lasch (= **P. vulgaris** Fr.)"). Furthermore his proceeding is not logical: before a non-typified genus can be synoymized, a "typus generis" must be designated.

His typification of the genus **Allophylaria** seems to be without contradiction. If we, however, pursue the use of this name in somewhat more detail, some absurdities arise: for the first time in 1869 KARSTEN used the name as section VI of the (collective) genus **Peziza**. In this section he placed two species: **P. eucrita** Karst. and **P. sublicoides** (11).

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(9) = Pezizella avellanae (Lasch) Fuckel.

(10) The genus is absent in FARR et al. (1979) and CLEMENTS & SHEAR (1931).

(11) In the index KARSTEN himself (1869, p. 205) changed the epithet : "**Peziza sublicoides** in **P. sublicaeformen** est emendanda". If the index is published at the same time as the main part, **P. sublicaeformis** is valid, otherwise this name is il-

287	9	*for*	death 1915.	*read*	death in 1915.
	32	*for*	typification	*read*	typifications
288	10	*for*	doubts	*read*	doubt
	29	*for*	and contradictory:	*read*	and is contradictory:
	38	*for*	synoymized,	*read*	synonymized,
	29	*for*	and contradictory:	*read*	and is contradictory:
	38	*for*	synoymized,	*read*	synonymized,
289	6	*for*	supposed	*read*	suppose
	38	*for*	single of	*read*	single one of

In the following year (1870, p. 243) he raised this section to generic rank and included four species within it: **A. eucrita** (Karst.) Karst., **A. sublicaeformis** (Karst.) Karst., **A. clavuliformis** (Karst.) Karst. and **A. byssacea** (Karst.) Karst. He affixed a question mark to the last three mentioned species: I supposed he was in the dark about the membership of these to **Allophylaria**.

Again one year later (1871) he considered his genus as a synonym of **Pezicula** Tul. and described in the following order six species:
1. **P. subliciformis** (Karst.) Karst., 2. **P. clavuliformis** (Karst.) Karst., 3. **P. byssacea** (Karst.) Karst., 4. **P. myrtillina** Karst., 5. **P. eucrita** (Karst.) Karst. and 6. **P. phyllophila** (Desm.) Karst. Nearly 15 years later (1885) he restored the genus to life, this time with four species, i.e. **A. subliciformis**, **A. clavuliformis**, **A. byssacea** and **A. phyllophila**. Until its resuscitation by NANNFELDT (1932) the name sank in a long sleep, apart from three new species descriptions by KARSTEN (1889) (12), CLEMENTS (1903) (13) and SPEGAZZINI (1926) (14) and the synonymizing with **Hyaloscypha** by BOUDIER (1907) (15).

KARSTEN himself never designated a "typus generis." According to the ICBN the type has to be selected from among the two species mentioned in the protologue. Doing this it would be wise not to fall back on a species which one year later (1870) was labelled by him with a question mark. From this viewpoint **P. eucrita** Karst. (= **Pezicula eucrita** (Karst.) Karst.) would be a suitable choice, especially as he himself synonymized his genus with **Pezicula** in 1871. In this case **Allophylaria** fide KARSTEN 1870 would become a synonym of **Pezicula** (16). Thus I cannot help feeling that in 1885 KARSTEN unconsciously created a later homonym, on which NANNFELDT (1932) founded his interpretation of **Allophylaria**, for he stated: "Sichere Arten dieser Gattung sind die Karstenschen **A. subliciformis**, **A. clavuliformis**, **A. byssacea** und **A. phyllophila**...," although he apparently did not study a single of these species, which KARSTEN regarded as belonging to **Allophylaria**; at least he did not mention any

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legal (Art. 63.1 ICBN). According to STAFLEU & COWAN (1979) KARSTEN's work was published between "2 Oct - 6 Nov 1869". I interpret this to the effect that the exact date of publication is unknown, and the article itself was published as one complete unit.

(12) **Allophylaria terrigena** Karst.

(13) **Allophylaria senecionis** Clem., although this species was described by CLEMENTS, he did not mention the generic name neither as a genus of its own or as a synonym in his "Genera of Fungi," published in 1909.

(14) **Allophylaria cordobensis** Speg.

(15) This synonymy is without any foundation, especially since none of KARSTEN's species is synonymized.

(16) **Peziza eucrita** Karst. was mentioned by NANNFELDT (1932) as a synonym of **Pezicula livida** (B. & Br.) Rehm.

examination in his work. The listed order of the species coincides exactly with KARSTEN's (1885) and probably was adopted from him.

NANNFELDT surely endeavoured to maintain KARSTEN's order, for it is very improbable that he got this sequence by chance. He expanded the genus to include six additional species, which I interpret as an emendation. Consequently he should have designated the type species of **Allophylaria** as "Neotypus," (17) but he only wrote "Typus."

The above mentioned statement offers a further, surprising interpretation to the typification of **Allophylaria**: under the Codes in effect from 1969 to 1987, KARSTEN could be said himself to have typified (1885) the genus by means of of "schizotypification," for he excluded all (**Peziza eucrita** Karst., = **Pezicula eucrita** (Karst.) Karst.) but one (**Peziza sublicoides** Karst.) of the original taxa. If this is accepted as the first valid and uncontradicted typification, which would coincide with NANNFELDT's choice, **Allophylaria** represents a genus of its own, which because of its anatomical characters (especially the jodine-positve asci and the large spores) cannot be united with **Pezizella.** But the use of "schizotypification" was outlawed at the Berlin Congress in 1987, with the result that **Allophylaria** could still be considered a synonym of **Pezizella** if NANNFELDT's neotype is not accepted. Finding no difficulty with NANNFELDT's conclusion, I accept that neotypification and believe that **Allophylaria** and **Pezizella** are not synonyms. Hence it will hardly be necessary to ascertain which of the names enjoys priority, because the two were both published in 1870, a problem which only would have to be solved if **Allophylaria** and **Pezizella** are synonyms.

IV. Peziza sordida Fuckel and Peziza avellanae Lasch - Synonyms of Peziza vulgaris Fr. ?

The lectotype species of **Pezizella** is **Pezizella sordida** (Fuckel) Fuckel, which was synonymized with **Pezizella avellanae** (Lasch) Fuckel (v. HÖHNEL 1926, NANNFELDT 1932, DENNIS 1956). **P. avellanae** itself was synonymized by KARSTEN (1870, 1871, 1885) with **Peziza vulgaris** Fr. (as **Helotium albellum** (With.) Karst.). This synonymy was accepted by REHM (1893), v. HÖHNEL (1926), NANNFELDT (1932) and DENNIS (1956), so that we have to discuss the above mentioned synonyms.

I studied several syntype specimens of Peziza avellanae and additional specimens filed under this name, (18) but never could find either asci, basidia or spores, although

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(17) "Den Terminus 'Neotypus' habe ich für diejenigen Arten angewendet, die bei der Emendierung einer Gattung als Typusart zu betrachten ist." NANNFELDT (1932, p. 8).

(18) Fungi rhen. # 2079, Rehm Asc. # 63.

289	6	*for*	supposed	*read*	suppose
	38	*for*	single of	*read*	single one of
290	14	*for*	of of	*read*	of
	21	*for*	jodine-positive	*read*	iodine positive

290	14	*for*	of of	*read*	of
	21	*for*	jodine-positive	*read*	iodine positive
291	2,23,26	*for*	fruting	*read*	fruiting
	16	*for*	species	*read*	species,
292	20	*for*	fruting		

fruiting bodies of different size and of different stages were cut. Thus the argument of overripe fruting bodies being studied is excluded. The question, whether an ascomycete is "hidden" behind this name, could not be clarified by light microscopical studies, and hence its solution is reserved for ultrastructural examinations, which, however, requires living specimens or for new technologies which allow one to do gene sequencing from herbarium specimens. Still not today, but in a few years; this will put a whole new light on just how valuable herbarium specimens are.

But nevertheless there are some significant differences between **Peziza avellanae** and **P. sordida**, even without the characters of the hymenium:

1. In **P. avellanae** the hyphae of the ectal excipulum, which are embedded in a gelatinous matrix in both species are clearly narrower in diameter and arranged more irregularly.

2. Macroscopically the receptacle of P. sordida shows a somewhat downy surface under the stereo- and/or reflected-light microscope, whereas **Peziza avellanae** looks smooth.

3. In 3% to 40% KOH dried fruting bodies of **P. avellanae** - oddly enough - never soak up completely, even being allowed to react up to 24 hours (a character which I also noticed in studying fruting bodies of **Guepiniopsis**, a basidiomycete). The apothecia of **P. sordida** reach their "life size" at the latest after 15 seconds under such tests.

On the basis of the above mentioned characters and qualities, I do not consider, in contrast to REHM (1893), v. HÖHNEL (1926), NANNFELDT (1932) and DENNIS (1956) - **P. avellanae** conspecific with **P. sordida,** which is in fact what FUCKEL also noted, since he distributed the two separately.

Because of the outlined obscurities **P. avellanae** is scarcely suitable to serve as a type species for the genus **Pezizella**, as v. HÖHNEL (1926) chose, quite apart from the fact that his typification was antedated by BACHMAN's in 1907 and from his use of the "first species rule" (cf. p. 286).

KARSTEN (1870) was the first to state the synonymy of **P. avellanae** with **P. vulgaris** which he also maintained in 1871 and 1885. SACCARDO's (1889) opinion is confused: on the one hand he quoted **P. avellanae** as a synonym of **Pezizella albella** (With.) Sacc. (about **Peziza albella** see below) (l.c. p. 280), a species which he, following FRIES (1823), considered as identical with **P. vulgaris** Fr. On the other hand (l.c. p. 278), he turned the tables and synonymized **Peziza albella** with **Pezizella vulgaris** (Fr.) Sacc. non **Pezizella vulgaris** (Fuckel) Sacc. (19). This is nomenclaturally untenable because a taxon "...with a circumscription, position and rank can bear only one correct name" (ICBN 1988, Art. 11, p. 14). REHM (1881) quoted **P. avellanae** as **Helotium albellum.** In 1893, however, he transfered this species as **Phialea vulgaris** (Fr.) Rehm to **Phialea.**

According to the short diagnosis one cannot recognize unquestionably which fungus FRIES meant by this name. In his herbarium in Upsala only one collection made by ROBERGE in France was found, which, however, did not contain any apothecia, and which judged by the label appears to be identical with DESMAZIÈRES's Pl. crypt. France ed. I # 1065. As FRIES (1823 p. 147) stated having seen **P. vulgaris** alive, I suppose DESMAZIÈRES's specimen could be perhaps identical with it, whereby a solution of the problem **P. vulgaris** could be offered.

But a study of the specimen from Paris was disillusioning: the sample only showed poor remains of fruting bodies, a duplicate from Genf was in better condition indeed, but no asci or spores could be found. The macroscopic and anatomical characters and the reaction in KOH were identical with **P. avellanae**, so that you can suppose with some probability that **P. vulgaris** Fr. sensu Desm. is conspecific with **P. avellanae** Lasch. This presumption does not clear either the identity of **P. avellanae** or that of **P. vulgaris**: whether DESMAZIÈRES's interpretation is really in accordance with FRIES's fungus has to remain unsettled, because - as already mentioned - it is not possible to tell from the brief description which fungus he had in mind, especially since FRIES classified it with the tribus "XI **Mollisia.**" **P. vulgaris** could be a **Mollisia** according to today's interpretation. Because of the sketchy facts, I refrain from designating a neotype for **P. vulgaris** at the moment, especially since this name has no

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(19) **Pezizella vulgaris** (Fuckel) Sacc. and **P. vulgaris** (Fr.) Sacc. are simultaneous homonyms which have equal priority, so that "the first of them that is adopted ... by an author who simultaneously rejects the other(s) is treated as having priority" (ICBN Art. 64.5, p. 67, 1988). This has not been done hithereto. Acccording to to my studies **Niptera vulgaris** Fuckel is identical with **Pezizella conorum** Rehm (cf. also v. HÖHNEL, 1926), the epithet of which is of doubtful validity on which already KEISSLER (1912) called attention to. In a further paper I shall return to this problem. These specimens are not congeneric with **Pezizella sordida** and until further notice they will stand as **Cystopezizella conorum** (Rehm) Svr. (= **Niptera vulgaris** Fuckel, = **Pezizella vulgaris** (Fuckel) Sacc. nom. illeg. ICBN 1988, Art. 64.5).
As Pezizella vulgaris (Fr.) Sacc. is "the homonym for the taxon that is not renamed (it) is treated as having priority" (l.c. p. 67). V. HÖHNEL (1926), by the way, created a third homonym **P. vulgaris** (Fr.) HÖHNEL, although MASSEE (1895) used P. **vulgaris** (Fr.) Sacc. as a synonym of **Pseudopeziza albella** (With.) Massee. MÜLLER (1977) classified **Peziza vulgaris** Fr. with **Hymenoscyphus: H. vulgaris** (Fr.) Raschle et Müller. This is a later homonym of **H. vulgaris** (Fr.) Lindau.

291	2,23,26	*for*	fruting	*read*	fruiting
	16	*for*	species	*read*	species,
292	20	*for*	fruting	*read*	fruiting
293	3	*for*	synoymized	*read*	synonymized

		for	fruting	*read*	fruiting
293	3	*for*	synoymized	*read*	synonymized
295	36	*for*	alraedy	*read*	already
296	11	*for*	jodine-positive	*read*	iodine-positive
	12	*for*	adequate to do not	*read*	not adequate to

significance concerning the typification of the genus **Pezizella**.
FRIES (1823) synoymized **P. vulgaris** with **P. albella** With. (20).Indeed WITHERING never published a fungus with this name, but the one to which FRIES referred, is called **P. albida** With. (WITHERING 1796, p. 350). Already STEUDEL (1824) (21) called attention to this error and was followed by PHILLIPS (1890), NANNFELDT (1939), and SEAVER (1951). WITHERING's fungus is clearly larger, found on a different substrate, and undoubtedly not identical with FRIES's **P. vulgaris**. According to NANNFELDT it is identical with, or closely allied to **Peziza Adae** Sadl." (l.c., p. 244).

V. Calycina Nees - an older name for Pezizella Fuckel and Cystopezizella Svrček?

Recently BARAL (in KRIEGELSTEINER & BARAL 1985) dealt with the genus **Pezizella**, which he synonymized with **Calycina** (Nees) Gray: "**Pezizella** Fuckel 1870 ss. Dennis pp." At the same time he considered **Cystopezizella** Svr. (SVRČEK 1983) as congeneric with **Calycina**, consequently **Calycina** must be congeneric with **Pezizella**, too.

A brief statement and explanation of my position is imperative: it is safe to say that **Pezizella** is not congeneric with **Cystopezizella** Svr. (type: **Pezizella conorum** Rehm). The two types differ clearly from each other not only in the characters of the excipulum but also in those of the hymenium. If these characters were not accepted as differences, no classification in genera and accordingly no systematics of the Leotiales would be realized. The same holds for the differences of **Calycina** and **Pezizella**.

The problem "**Calycina** = **Cystopezizella**" is somewhat more complicated: The name **Calycina**, which was raised by GRAY (1821) to generic rank is traced back to NEES von ESENBECK (1817). The genus itself was lectotypified with **Peziza herbarum** Pers. by DUMONT (1972) (22). This species was

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(20) CLEMENTS & SHEAR (1931) lectotypified **Phialea** (Pers.: Fr.) Gillet with this name; cf. also CARPENTER (1981).

(21) Thus already one year after the publication of the Systema: "Vitiose in Friesio: albella" (l.c. p.330). In the "Index alphabeticus" (FRIES, 1832) "albella" is missing, but "albida" is listed and with that sanctioned. Even KUNTZE (1898) used the "phantom:" **Hymenoscypha albella** (Fr.) Ktze.; the combination **Hyalinia albella** (With.) Boud. is just as absurd.

(22) "Erste Sippschaft. Familia prima ... (Calycinae)." NEES ranked with this "Sippschaft" four species: **P. sphaerioides** Roth., **P. urceolus** Alb. & Schw. **P. herbarum** Pers. and **P. pallescens** Pers. The first and the third were studied by himself and accampanied by illustrations. Furthermore he ranked with "Calycinae alle gestielten (Arten) aus Persoons 5ter Abtheilung (E.) Coriaceae, siccae" (l.c. p. 264). Thus DUMONT's statement, "he (NEES) included four species" (DUMONT l.c. p. 913) is incorrect and an additional 15 species have to be taken into consideration as a possible lectotype. It is, however, right to reject SEAVER's

described by PERSOON (1794), who also listed it in his later publications (e.g. 1797, 1801, and 1822, however not 1796/1799). As I often stumbled on **P. herbarum** during my studies of the genus **Pezizella**, and, as I agree with KORF (KORF in KRIEGELSTEINER & BARAL 1985) that this species is out of place in **Hymenoscyphus**, I wanted to study PERSOON's specimen, which was made available to me from Leiden generously. I got six collections with this name. As PERSOON did not designate a holotype a lectotype specimen has to be choosen from these:
Three specimens could be excluded from the beginning, according to the hand-writing two are collected and labeled by himself: 1. "**Peziza** affinis **P. herbarum** (substrate is not named, fragments of twigs) and 2. "**Peziza herbarum** var." (fragments of twigs, too). In addition both gatherings are named with the entry "Hb. Pers." The third is entitled "Desm. in Hb. Pers., No. 9 **Peziza herbarum** ? Pers."

The remaining three specimens which according to the substrate were suitable as a type are labeled "Hb. Pers., Chaill. in Hb. Pers., Moug. in hb. Pers.," respectively. The first mentioned specimens ("Hb. Pers., Prope Gottingen (sic!) lecta"), would be first quality, from which you can conclude with some probability that it was collected by himself, for PERSOON (born 1761/62 in South Africa) studied medicine and natural history in Göttingen from 1787 to 1802. Unfortunately he did not specify the date of collection. Hence it is uncertain whether he described **P. herbarum** by means of this specimen, for just as well it is possible that he only collected it after 1794, so that, in my opinion, this does not appear qualified as a lectotype, and I disregard it as a neotype, too, because the material is rather scanty.

The remaining specimens, collected by CHAILLET and MOUGEOT, certainly got into PERSOON's hands only after 1794, for, according to the hand-writing the lettering does not date from him, but the label already bears the name "**Peziza herbarum** Pers." Thus neither of the two specimens can be used as lectotype specimen, too, even though PERSOON did not add critical notes and hence surely accepted them as identical with "his" **P. herbarum**. I select MOUGEOT's gathering (# 910.261-431) as the neotype of **P. herbarum** Pers., because the substrate is designated and the original description of the apothecia corresponds with the specimen. The microscopic study of this and of PERSOON's and CHAILLET's specimens showed that the excipu-

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typification, who typified this genus with **Peziza firma** Pers. in 1934, because this species was not mentioned even among the 15 additional ones. PERSOON (1822) considered NEES's **P. herbarum** as a synonym of his **P. scutula** Pers. In this interpretation he was followed by all later authors, e.g. FRIES (1823), WALLROTH (1831) and Rabenhorst (1844). Thus, if PERSOON's interpretation is right, the typification of **Calycina** with **Peziza herbarum** Pers. nec Nees becomes questionable, too, because this species does not belong to the "Gründungsarten."

	[illegible]	*for*	species	*read*	species,
292	20	*for*	fruting	*read*	fruiting
293	3	*for*	synoymized	*read*	synonymized
295	36	*for*	alraedy	*read*	already
296	11	*for*	jodine-positive	*read*	iodine-positive

lum is not composed of rectangular cells (textura prismatica to textura angularis), as it is delineated by DENNIS (1956), but of extended, narrow and strongly interwoven hyphae, the arrangement of which is difficult to follow not only in longitudinal sections but also in crush mounts. Also the downy structure of the surface of the receptacle can hardly be seen. The spores correspond well in form and size (14-16 x 2.5 µm) as in the number of the septa (two-celled) with those represented by DENNIS (1956) and BREITENBACH & KRÄNZLIN (1981). The asci, however, are clearly shorter (not exceeding 60 x 6 µm).

If these species belong to **P. herbarum**, in spite of the outlined differences, the value of the excipulum as a systematic character again would be made dubious. It is rather more probable that the name "herbarum" was and is used by different authors for different species, which also my own gatherings on **Urtica** indicate. However, studies hereto are not closed . If this presumption will be corroborated in the last analysis, **Calycina** and **Cystopezizella** surely are not congeneric and the placement of **P. herbarum** remains vague, too.

VI. The generic names Eubelonis Clem. and Eubelonis Höhnel

CLEMENTS (1909) founded the genus **Eubelonis** with **Helotium drosodes** Rehm. V. HÖHNEL (1918) transferred this species to **Belonioscypha.** In 1926 he placed a fungus in **Eubelonis** which was determined by SACCARDO (Mycoth. veneta # 1509) as **Helotium subcarneum** (Schum.) Sacc., and which he named **Eubelonis albosanguinea** Höhn. According to the rules of the ICBN v. HÖHNEL thus created a later homonym, **Eubelonis** Höhnel, the use of which as a name of a genus is invalid (cf. also CARPENTER 1981). GRADDON (in CLARK, 1980) thought this species belongs to **Pezizella.** This was not confirmed by my investigations of the above mentioned specimen. **E. albosanguinea** Höhnel seems to be a member of a genus of its own, for no suitable place in an alraedy existing genus has been found until now. My efforts on this are still incomplete.

The study of **Helotium drosodes**, the type species of **Eubelonis** Clem., produced a surprising result: a free and easy classification with **Pezizella** is allowed not only by the anatomical characters of the excipulum but also by the structures of the asci, so that we regard **Eubelonis** Clem. as a synonym of **Pezizella** until further notice.

In this connexion we have to examine a further synonym, which was mentioned by v. HÖHNEL (1926), viz. **Ctenoscypha**, more detailed **Pezizella** subgenus **Ctenoscypha** Starb. Within the scope of a short treatment of **Pezizella** this subgenus was founded by STARBÄCK (1895) together with the subgenus **Eupezizella.** He placed into **Ctenoscypha** -in the following order - **Pezizella dilutelloides** Rehm, **P. helotioides**

Starb. and, with some doubt, **P. punctiformis** (Grev.) Rehm. V. HÖHNEL (l.c.) regarded **P. dilutelloides** as the "Grundart" of **Ctenoscypha** (once again according to "the first species rule") because in his opinion it is constructed completely as in **P. vulgaris**, thus **Ctenoscypha** would be identical with **Pezizella.**

Although some similarities in structure of the excipulum are recognizable between **P. sordida** and **P. dilutelloides**, the structure of the asci (the apices of the latter are ± thickened and with and without KOH pretreatment jodine-positive) argues against v. HÖHNEL's position: in my opinion these differences are adequate to do not classify **P. dilutelloides** with **Pezizella**, i.e. **Pezizella** Fuckel subgenus **Ctenoscypha** is not a synonym of **Pezizella** Fuckel (23).

VII. The genus Pseudohelotium Fuckel

A further genus which is frequently mentioned in connexion with **Pezizella**, is **Pseudohelotium** Fuckel (24)(e.g. DENNIS 1960, 1968, 1978).(25) It was also founded by FUCKEL (1870) with:

1. **Pseudohelotium pineti** (Batsch) Fuckel
2. **Pseudohelotium puberulum** (Lasch) Fuckel
3. **Pseudohelotium hyalinum** (Pers.) Fuckel.

Again he did not designate a "typus generis," this only being done by v. HÖHNEL (1923) and CLEMENTS & SHEAR (1931). In each case the authors selected the first species: v. HÖHNEL anew used the "first species rule"(26). Whether CLEMENTS & SHEAR adopted his typification, or whether they typified the genus themselves, is unclear. In the bibliography of their book, in any case, v. HÖHNEL's posthumous published work cannot be found. Together with their typification CLEMENTS & SHEAR synonymized **Pseudohelotium** with **Belonium** Sacc. and typified this genus with exactly the same species. As **Peziza pineti** does not belong to the "Gründungsarten" of **Belonium** it is out of question as a type for this genus (cf. also KORF, 1978). If we, following KORF, accept the typifications by CLEMENTS & SHEAR as not arbitrarily, i.e., as a result of the "first species rule" (27) and, as far as they do not violate other rules of the ICBN, **Pseudohelotium pineti**

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(23) Already NANNFELDT (1932) and ARENDHOLZ (1979) expressed doubts about the membership of this species to **Pezizella.**
SEAVER (1951) synonymized **Pezizella** together with **Myridium** Clem. (Type: **Calloria myriospora** Phill. & Hark. = **Laetinaevia myriospora**; cf. HEIN, 1976) and **Orbilia** Fr. This is entirely unfounded.

(24) FARR et al. (1979): "T.(ypus): non designatus".

(25) "The general aspect is that of a **Pezizella** with acicular spores" (l.c., 1978, p. 126).

(26) "Diese Gattung (**Pseudohelotium**) stellt Fuckel (Symb. myc. 1869, p. 298) auf Grund von **Peziza Pineti** Batsch 1786 auf" (l.c., p. 113).

(27) "In no manner of thinking can these designations be considered 'first cited species as type' example" l.c. , p. 494.

295	36	*for*	alraedy	*read*	already
296	11	*for*	jodine-positive	*read*	iodine-positive
	12	*for*	adequate to do not	*read*	not adequate to
	31	*for*	posthumous	*read*	posthumously
	38	*for*	arbitrarily,	*read*	arbitrary,
297	6	*for*	akward	*read*	awkward
	9	*for*	transfered	*read*	transferred
	27,37	*for*	jodine-positive	*read*	iodine-positive
298	37	*for*	with in	*read*	within

(Batsch) Fuckel is the "typus generis" of **Pseudohelotium**, for which a neotype has to be designated, because in BATSCH's herbarium in Jena no specimen remains.

VIII. Some systematic consequences

If we use **Pezizella** in the sense of **Pezizella sordida**, some akward consequences arise:

1. Nearly all species bearing the name **Pezizella** (e.g. in CANNON et al., 1985, ENDERLE in KRIEGELSTEINER, 1983 etc.) have to be removed from the genus and to be transfered to existing and/or many times in newly-to-be-founded genera.

2. The second consequence, which does not arise from the typification of the genus **Pezizella** itself, and which is connected with it only indirectly, viz. by using the characters of the genus to delimit it from neighbouring ("related") ones, is of greater significance, because, used for other genera and families of the Leotiales, it could change the system (classification) of the order greatly: the systematic value of the characters, which we learn from the species, are at stake.

The delimitation and independence of Pezizella from "related" genera (e.g., **Bisporella**, **Stamnaria**, **Crocicreas** etc.) is not realized totally by the structure of the excipulum. In addition to the excipulum I directed my attention to the structures of the asci, which in **Pezizella** are rounded at the apex. The lateral walls and the apex itself are of equal thickness. They are jodine-negative in MELZER's reagent (and also in LUGOL's solution) both without or with KOH pretreatment (in contrast to e.g. **Bisporella** Sacc.), a character which is predicted by light optic analysis: the often linear wall thickening, which is recognized exceptionally clearly in differential interference contrast microscopy according to Nomarski, but it is also observed by trained eyes in bright field microscopy, is missing in **Pezizella sordida**.

In other words, if these (linear) light-optic discernible thickenings always exist at the ascus apex, the asci of the Leotiales are jodine-positive. Because of the smallness of these structures, a statement about their structure is impossible, for true images of structures are only possible if these reach a dimension of 1-4 µm, hence roughly five- to tenfold of the lateral resolution. For less than 1-4 µm it can only be ascertained whether "something is there," and morphological definitions of light microscopic images disappear in useless speculations (cf., e.g., ABBE 1873, ANONYMUS 1971, KRAMMER 1979, 1981) (28).

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(28) "...weil immer wieder die Auflösungsgrenze des Lichtmikroskops... mit der Auflösbarkeit morphologischer Strukturen gleichgesetzt wird." (KRAMMER 1979, p. 70); "Distinctions should always be made between resolving power and what can be

If these facts are not borne in mind errors and misunderstandings easily can arise by analyzing very small structures in the light microscope: e.g., as when BARAL (1987) stated that he saw four layers of even different thickness in a roughly 1 µm thick ascus wall in inoperculate asci (surely with reference to BELLEMÈRE's (1977) ultrastructural studies).

Similar considerations are put forward if structures the size of which touches the resolution of the light microscope should be found again in the TEM. A request such as: "Es sollte doch möglich sein, diese Strukturen (29) elektronenoptisch nachzuweisen und exakt zu lokalisieren!" (BARAL 1987, p. 123) is of little help, for it would be difficult to fix and embed a "structure", which is, e.g., due to diffraction and to prepare from that ultra-thin sections.

The non-observance of the above mentioned considerations may have contributed to the result, that the (three) "categories of asci" of the French school (cf., e.g., CHADEFAUD 1942, 1960, 1973) have not been accepted by many mycologists, because they could not reconstruct the observations of the corresponding characters. (30)

Nevertheless for a long time the structures of the asci have been used as an important (most important?) criterion in classifying the ascomycetes into higher taxa. Also at the level of families and genera these characters should yield reliable "tools" to distinguish between these, especially in correlation with other characters as, e.g., excipulum, spores, etc. Therefore we agree with HAFFELNER, who wrote (1984, p. 255): "Verschiedene Ascustypen dürfen in der Regel in einer Gattung (Familie) nicht vorkommen. Grundsätzlich ist also mit dem Ascustyp die Gattung (Familie) definiert." In my opinion, a further important principle is defined by this statement, which is often violated, although it is a commonplace, viz., that the characters defining, e.g., a genus are valid in all taxa, which are classified with in this genus. In other respects the circumscriptions of the genera would be watered down in such a manner that we cannot speak of genera any more, a situation which holds true for many genera of the Leotiales today. Yet I am absolutely aware that the species of a genus have to differ from the type species in definite characters, for otherwise at the end the number of the genera becomes nearly as great as the number

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seen with the microscope. Such differentiation is seldom clear to the microscopists" (NEEDHAM 1958, p. 223).

(29) Certain structures of the apical apparatus of the asci are meant.

(30) "A demonstration set up by Professor M. Chadefaud at the 1957 9th International Botanical Congress in Paris, France, especially to show the various ascus types failed to convince other ascomycete workers of the reality of the configurations seen in the ascus wall (pers. comm. with various mycologists)." (REYNOLDS, 1989, p. 15)

	31	*for*	posthumous	*read*	posthumously
	38	*for*	arbitrarily,	*read*	arbitrary,
297	6	*for*	akward	*read*	awkward
	9	*for*	transfered	*read*	transferred
	27,37	*for*	jodine-positive	*read*	iodine-positive
298	37	*for*	with in	*read*	within
322	6	*for*	local	*read*	locality
339	c. 2, 31	for	*violaceous*	read	*violaceus*

of the species. But a genus, as, e.g., described by CARPENTER (1981) for **Crocicreas**, in which the majority of the variations of morphological and anatomical characters recognized throughout the order are used, seems not very "natural" to me.

In my opinion only increased and joint efforts and co-operation of many mycologists in as many countries as possible will perhaps lead to a more natural system of the Leotiales, possibly with a change of the "paradigm." But I think it is still a long journey to that time.

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THREE NEW SPECIES IN THE LICHEN GENUS PARMELIA (PARMELIACEAE, ASCOMYCOTINA) FROM SOUTHERN AFRICA, WITH FURTHER NOTES

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ABSTRACT

Three new species of *Parmelia* (Parmeliaceae, Lichenized Ascomycetes) are described from southern Africa. They are: *Parmelia festiva* Brusse, *P. infausta* Brusse and *P. ponderosa* Brusse. Two new combinations are made: *Parmelia areolata* (Hale) Brusse and *Parmelia colensoica* (Nash, Elix & Johnston) Brusse. One new lichen record for southern Africa is reported, and one is deleted. Notes on three *Parmelia* species are given.

NEW SPECIES

Parmelia festiva Brusse, *sp. nov.* Fig. 3

Thallus minute foliosus, saxicola, usque ad 5 cm diametro, sat vel laxe adnatus. *Lobi* sublineares, 0,1–0,8 mm lati, 115–400 μm crassi. *Thallus superne* flavo-viridis, nitidus, pustuli-soraliatus, epicortice poroso. *Soralia* viridia, capitata, 0,2–0,8 mm diametris. *Soredia* granularia, 35–80 μm diametris. *Cortex superior* 15–25 μm crassus. *Stratum gonidiale* 35–75 μm crassum, algis *Trebouxiis* 5–18 μm diametris. *Medulla* albida, 20–230 μm crassa. *Cortex inferior* 5–15 μm crassus. *Thallus inferne* piceus, sat rhizinatus. *Rhizinae* simplices, 60–95 μm crassae. *Apothecia* adnata, usque ad 1,2 mm diametris. *Hypothecium* hyalinum, 20–55 μm crassum, J −. *Subhymenium* hyalinum, 10–35 μm crassum, J −. *Hymenium* hyalinum, 50–60 μm crassum, J + caeruleum. *Asci* clavati, tholis J + caeruleis (figura 1). *Ascosporae* octonae, hyalinae, simplices, ellipsoideae, 8,5–11,5 × 5,5–7,0 μm. *Pycnidia* globosa, hyalina, 100–120 μm profunda, 80–100 μm lata. *Pycnidiosporae* longe aciculares, hyalinae, 12–22 × 0,8 μm, rectae vel subrectae. *Thallus* acidum usnicum, acidum rhizocarpicum, acidum gyrophoricum, acidum protoconstipaticum et acidum constipaticum continens.

TYPUS: SOUTH AFRICA, CAPE PROVINCE—**3319** (Worcester): Summit of Jona's Kop in the Riviersonderend Mountains near Villiersdorp. On Table Mountain Sandstone rocks on N slope. Alt. 1630 m (−**DC**). *F. Brusse 5454*, 21. iii. 1988 (**PRE**, holo-; **ANUC, BM, LD, US**, iso-). Figura 3.

Thallus minutely foliose, saxicolous, up to 5 cm across, moderately to loosely adnate. *Lobes* sublinear, 0,1–0,8 mm wide, 115–400 μm thick. *Upper surface* yellow-green, glossy, pustular-soraliate, epicortex pored. *Soralia* green, capitate, 0,2–0,8 mm across. *Soredia* granular 35–80 µm diam. *Upper cortex* 15–25 µm thick. *Algal layer* 35–75 µm thick, algae *Trebouxia*, 5–18 µm diam. *Medulla* whitish, 20–230 µm thick. *Lower cortex* 5–15 µm thick. *Lower surface* black, moderately rhizinate. *Rhizines* simple, 60–95 µm thick. *Apothecia* adnate, up to 1,2 mm across. *Hypothecium* hyaline, 20–55 µm thick, J –. *Subhymenium* hyaline, 10–35 µm thick, J –. *Hymenium* hyaline, 50–60 µm thick, J + blue. *Asci* clavate, eight-spored, tholus J + blue (figure 1). *Ascospores* hyaline, simple, ellipsoid, 8,5–11,5 × 5,5–7,0 µm. *Pycnidia* globose, hyaline, 100–120 µm deep, 80–100 µm wide. *Pycnidiospores* long hyaline needles, 12–22 × 0,8 µm, straight to slightly curved. *Chemistry*: Usnic and rhizocarpic acids in the upper cortex, gyrophoric, protoconstipatic and constipatic acids in the medulla.

The occurrence of rhizocarpic acid has no precedent in the genus *Parmelia*, and causes the upper surface to fluoresce dull orange in long wave ultra-violet light. This unique species is also pustular-soraliate, which is quite uncommon among the *Xanthoparmeliae*, so far being known only in *P. ganymedea* Brusse (1988b) and *P. geckonalis* Brusse (1989; = *Xanthoparmelia saleruptens* Hale 1989) for southern Africa.

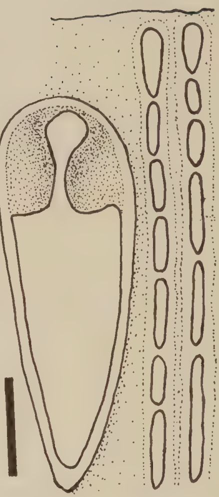


FIGURE 1.—*Parmelia festiva* Brusse, ascus and paraphyses. *F. Brusse 5454*, holotype. Bar = 10 µm.

Parmelia festiva could also be confused with *Xanthoparmelia olivetorica* Hale (1986), which it resembles both in general appearance and in chemistry, but is easily distinguished by the presence of pustular-soralia and the dull orange colour in long wave ultra-violet light, due to the presence of rhizocarpic acid in the cortex. The medullary chemistry of these two species is the same, both containing gyrophoric, protoconstipatic and constipatic acids. In fact, these two species grow together in the same spot on Jona's Kop, where the type material of *P. festiva* was obtained.

This new species is thus far known only from the type locality, the summit of Jona's Kop in the Riviersonderend Mountains closest to the town of Villiersdorp, in the south-western Cape.

Parmelia infausta Brusse, *sp. nov.* Fig. 4

Thallus minute foliosus, saxicola, usque ad 4 cm diametro, arcte adnatus. *Lobi* elongati, 0,2–1,0 mm lati, 70–220 µm crassi. *Thallus superne* viridis, nitidus, isidiatus, epicortice poroso. *Isidia* globosa vel sphaerica, simplicia (Fig. 5). *Cortex superior* 9–14 µm crassus. *Stratum gonidiale* 15–70 µm crassum, algis *Trebouxiis*, 6–23 µm diametris. *Medulla* alba, 10–120 µm crassa. *Cortex inferior* 8–10 µm crassus. *Thallus inferne* pallide brunneus, sat rhizinatus. *Rhizinae* parvae. *Apothecia* adnata, plana, usque ad 0,7 mm diametris. *Hypothecium* hyalinum, 10–50 µm crassum, J –. *Subhymenium* hyalinum, 10–20 µm crassum, J + pallide caeruleum. *Hymenium* hyalinum, 40–50 µm crassum, J + caeruleum. *Asci* clavati, tholis J + caeruleis (figura 2). *Ascosporae* octonae, hyalinae, simplices, ellipsoideae, 8,0–11,0 × 5,5–6,5 µm. *Pycnidia* globosa, hyalina, 90–110 µm profunda, 70–90 µm lata. *Pycnidiosporae* aciculares, hyalinae, 5–8 × 0,8 µm. *Thallus* acidum usnicum et norlobaridonum continens.

TYPUS: SOUTH AFRICA, TRANSVAAL—**2428** (Nylstroom): 5 km from the main Potgietersrus-Naboomspruit road to Sterk River, farm Waterval 297 KR. On talus rocks at base of SE Waterberg Sandstone cliffs. Alt. 1190 m (−**BD**). *F. Brusse 5613*, 31. v. 1989 (**PRE**, holo-; **ANUC, BM, LD, US**, iso-). Figura 4.

Thallus minutely foliose, saxicolous, up to 4 cm across, tightly adnate. *Lobes* elongate, 0,2–1,0 mm wide, 70–220 μm thick. *Upper surface* green, glossy, isidiate, epicortex pored. *Isidia* globose to spherical, simple (Fig. 5). *Upper cortex* 9–14 μm thick. *Algal layer* 15–70 μm thick, algae *Trebouxia*, 6–23 μm diam. *Medulla* white, 10–120 μm thick. *Lower cortex* 8–10 μm thick. *Lower surface* pale brown (tan), moderately rhizinate. *Rhizines* small. *Apothecia* adnate, plane (flat), up to 0,7 mm across. *Hypothecium* hyaline, 10–50 μm thick, J −. *Subhymenium* hyaline, 10–20 μm thick, J + pale blue. *Hymenium* hyaline, 40–50 μm thick, J + blue. *Asci* eight-spored, clavate, tholus J + blue (figure 2). *Ascospores* hyaline, monolocular, ellipsoid, 8,0–11,0 × 5,5–6,5 μm. *Pycnidia* globose, hyaline 90–110 μm deep, 70–90 μm wide. *Pycnidiospores* hyaline needles, 5–8 × 0,8 μm. *Chemistry*: usnic acid in the cortex, norlobaridone and an unidentified substance in the medulla.

This new species is similar to *Parmelia exillima* Elix (1981), but the latter is an even smaller species with lobes up to 0,5 mm wide and cylindrical isidia (Elix 1981, Elix, Johnston & Armstrong 1986). *P. infausta* has globose to spherical isidia (figure 5) and has lobes up to 1 mm broad. The ascospores of *P. infausta* seem slightly larger (8–11 × 5,5–6,5 μm) than those of *P. exillima* (7–9 × 4–5,5 μm. Elix, Johnston & Armstrong 1986).

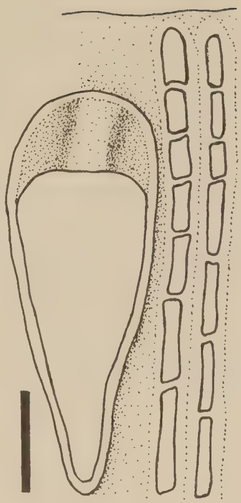


FIGURE 2.—*Parmelia infausta* Brusse, ascus and paraphyses. *F. Brusse 5613*, holotype. Bar = 10 μm.

Another similar species is *Xanthoparmelia lynii* Elix & Johnston (1988), but this is a larger and looser lichen with imbricated and rolled lobes. *X. lynii* contains a minor amount of loxodin with the norlobaridone, whereas *P. infausta* contains no trace of loxodin, but an unidentified substance instead.

At present this new species is known only from the type locality near Potgietersrus.

Parmelia ponderosa Brusse, *sp. nov.* Fig. 6

Thallus minute foliosus, saxicola, usque ad 4 cm diametro, sat vel laxe adnatus. *Lobi* sublineares, 0,1–0,8 mm lati, 70–220 μm crassi. *Thallus superne* viridis, nitidus, isidiis sorediisque destitutus, valde nigromarginatus, epicortice poroso. *Cortex superior* 18–30 μm crassus. *Stratum gonidiale* 30–65 μm crassum, algis *Trebouxiis*, 4–17 μm diametris. *Medulla* albida, 10–140 μm crassa. *Cortex inferior* 10–20 μm crassus. *Thallus inferne* piceus, sat rhizinatus. *Apothecia* non visa. *Pycnidia* globosa, hyalina, 100–110 μm profunda, circa 100 μm lata. *Pynidiosporae* hyalinae, aciculares, 12–23 × 0,8 μm. *Thallus* acidum isousnicum, acidum gyrophoricum et duo pigmenta ignota continens.

TYPUS: SOUTH AFRICA, CAPE PROVINCE—**3419** (Caledon): Summit of Galgeberg near Greyton (but accessed via McGregor), farm Galge Berg. On S face of Table Mountain Sandstone cliff on steep S slope. Alt. 1410 m (−**BA**). *F. Brusse 5490*, 22. iii. 1988 (**PRE**, holo-; **LD**, iso-). Figura 6.

Thallus minutely foliose, saxicolous, up to 4 cm across, moderately to loosely adnate. *Lobes* sublinear, 0,1–0,8 mm broad, 70–220 μm thick. *Upper surface* green, glossy, non-isidiate and non-sorediate, strongly black-margined, epicortex pored. *Upper cortex* 18–30 μm thick. *Algal layer* 30–65 μm thick, algae *Trebouxia*, 4–17 μm diam. *Medulla* whitish, 10–140 μm thick. *Lower cortex* 10–20 μm thick. *Lower surface* black, moderately rhizinate. *Apothecia* not seen. *Pycnidia* globose, hyaline, 100–110 μm deep, about 100 μm wide. *Pycnidiospores* hyaline needles, 12–23 × 0,8 μm. *Chemistry*: isousnic acid in the cortex, gyrophoric acid and the two "schenckiana pigments" in the medulla.

This new species resembles *Parmelia endochromatica* (Hale) Brusse (1988b) rather uncannily, but contains isousnic acid instead of usnic acid and has much longer pycnidiospores. The occurrence of isousnic acid has a precedent in *P. lurida* Brusse (1988a), but this lichen contains stenosporonic acid as the major medullary substance (see below), and does not have strongly blackened lobe margins.

Although the original description of *P. endochromatica* (Hale) Brusse states that pycnidia are lacking (Hale 1986), pycnidia were in fact found on the isotype housed at PRE. The pycnidiospores of *P. endochromatica* are the usual hyaline needles, but they are only 6–8,5 μm long, compared to the 12–23 μm length of those of *P. ponderosa*.

For the rest, the two species are very similar, with strongly blackened margins, which give the internodes a constricted appearance, and the overall lichen a subsquamulose appearance. The medullary chemistry of *P. endochromatica* and *P. ponderosa* is the same.

Thus far, this new species is known only from the type collection, from the summit of Galgeberg in the Riviersonderend Mountains, near the village of Greyton.

NOTES AND NEW COMBINATIONS IN *PARMELIA*

Parmelia areolata (Hale) Brusse, *comb. nov.*

Basionym: *Xanthoparmelia areolata* Hale, Mycotaxon **29**: 251. 1987.

More material of this lichen collected from the northern Transvaal, shows that this is clearly a pustular species, and the use of the term 'isidia' in the original description is misleading. The isotype at PRE has warty dactyls up to 1 mm across, which are not yet pustulate, however. The additional material also shows that this is not a small species, and the lobes are between 1 and 2 mm broad, as can be seen on the lower part of the original photograph of the type.

Xanthoparmelia centralis Elix & Johnston is clearly not a pustular species (Elix, Johnston & Armstrong 1986, fig. 7).

Parmelia colensoica (Nash, Elix & Johnston) Brusse, *comb. nov.*

Basionym: *Xanthoparmelia colensoica* Nash, Elix & Johnston, Mycotaxon **33**: 355. 1988.

This is a rather similar species to *Parmelia stenosporonica* (Hale) Brusse, but contains colensoic and norcolensoic acids as major constituents instead of stenosporonic acid. This species has now been collected on Table Mountain near Cape Town some 80 km SW of the type locality, Bain's Kloof. So far, *P. stenosporonica* has not been recovered from the south-western Cape, and is only known from the Swartberg Mountains at high altitude.

SOUTH AFRICA. CAPE PROVINCE—**3318** (Cape Town): Cape Town, south side of summit of Table Mountain. On S face of Table Mountain Sandstone outcrop. Alt. 980 m (–**CD**). *F. Brusse 5418*, 19. iii. 1988 (**BM, LD, PRE**).

Parmelia inuncta Brusse, *Mycotaxon* **27**: 187. 1986.

The range of this lichen has been increased from the original Robinson's Pass to Table Mountain at Cape Town.

As mentioned by Brusse (1988b) the type material and description of *Xanthoparmelia olivetorica* Hale (1986) is based on a mixture of *Parmelia astricta* Brusse and a new lichen containing usnic and gyrophoric acids. However, this lichen is not at all related to *P. endochromatica*, as suggested (Brusse 1988b), but to *P. inuncta*. More material of *Xanthoparmelia olivetorica* was collected from Table Mountain (*F. Brusse 5441*, **BM, PRE**) and this material contains usnic, gyrophoric, protoconstipatic and constipatic acids. The paratype material of *X. olivetorica* (*Hale 72080*, **PRE**) has no detectable amounts of protoconstipatic and constipatic acids. These aliphatic γ-lactones show-up as white spots on TLC plates in long wave ultra-violet light, after developing with sulphuric acid and heat. These two names (which were published simultaneously) may therefore refer to the same species.

SOUTH AFRICA, CAPE PROVINCE—**3318** (Cape Town): Cape Town, east side of summit of Table Mountain near Maclear's Beacon. On low Table Mountain Sandstone pavement on gentle NE slope. Alt. 1040 m (–**CD**). *F. Brusse 5426*, 19. iii. 1988 (**ANUC, BM, LD, PRE, S, US**).

Parmelia lurida Brusse, *Mycotaxon* **31**: 157. 1988.

The chemistry of this species has been determined as isousnic acid in the cortex, and stenosporonic (major), divaronic (minor) and colensoic (minor) acids in the medulla, by Dr J. A. Elix, G. A. Jenkins and Jen Johnston (Canberra). This occurrence of isousnic acid was unprecedented in the *Xanthoparmeliae*, but has been found since in the unrelated *P. ponderosa* Brusse (see above).

Parmelia lurida must therefore be closely related to *P. stenosporonica* Hale, with the identical medullary chemistry and similar morphology. More material is required to clarify the status of this species.

Parmelia squamatica Brusse, *Mycotaxon* **27**: 242. 1986.

An isotype of this lichen, with a beautiful white fluorescent medulla in long wave ultra-violet light, has been deposited at **PRE**. The holotype is at **J**.

MISCELLANEOUS NOTES

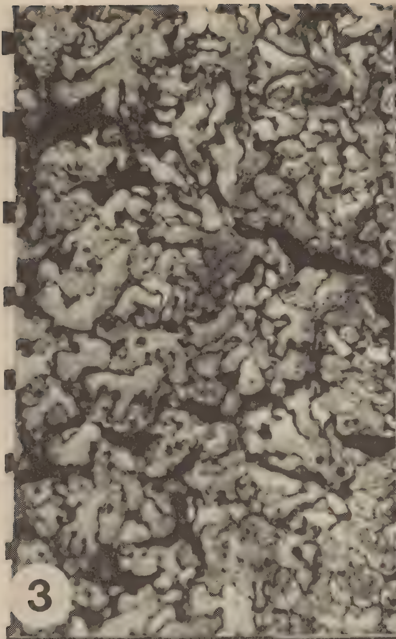
Phyllopsora haemophaea (Nyl.) Müll. Arg.

This species was recently cited as a new record for the flora of southern Africa (Brusse 1988b), but this determination has been amended to *Ph. pannosa* Müll. Arg. (see below) on the basis of chemistry, and is hereby deleted.

Phyllopsora pannosa Müll. Arg.

The chemistry of a lichen cited as *Ph. haemophaea* (Brusse 1988b), was recently checked by TLC, and found to lack the 'haemophaea unknown', but to contain atranorin and a major terpene (R_f classes 6: 7–8: 6) as does *Phyllopsora pannosa* (Swinscow & Krog 1981). The determination of this material has therefore had to be amended to *Ph. pannosa*, despite the rather pale hypothecium. *Phyllopsora pannosa* is also a new record for the flora of southern Africa, and is herewith enstated as such.

Further material (*F. Brusse 1846*) has been distributed to **BM, CBG, COLO, E, O, S, UPS, UC, US**, over and above the original **LD** and **PRE**.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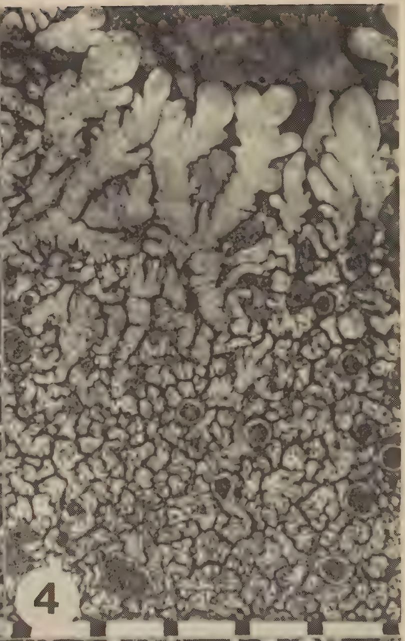
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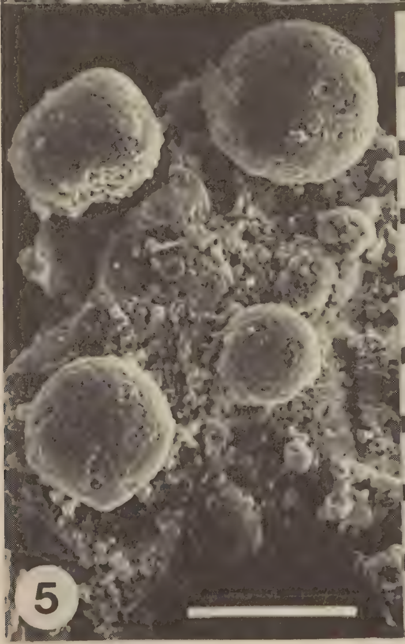
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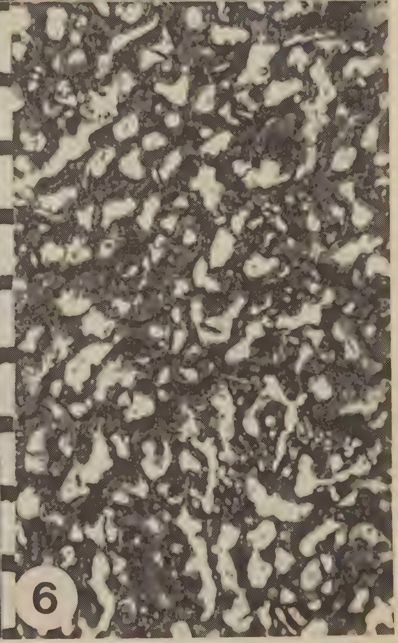
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FIGURE 3.—*Parmelia festiva* Brusse, habit. *F. Brusse 5454*, holotype. Scale in mm.

FIGURE 4.—*Parmelia infausta* Brusse, habit. *F. Brusse 5613*, holotype. Scale in mm.

FIGURE 5.—*Parmelia infausta* Brusse, scanning electron micrograph of the isidia. *F. Brusse 5613*, holotype. Bar = 100 μm.

FIGURE 6.—*Parmelia ponderosa* Brusse, habit. *F. Brusse 5490*, holotype. Scale in mm.

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OF RESEARCH ON TAXONOMY & NOMENCLATURE OF FUNGI & LICHENS

Vol. XXXVI January-March 1990 No. 2

CONTENTS

Entolomataceae in eastern North America I: new species of *Claudopus* and *Rhodocybe* from the southern Appalachian Mountains. **Timothy J. Baroni** 313
Contribution to the lichen flora of Brazil. XXIV. Lichens from Nova Petropolis, Rio Grande do Sul State. **Héctor S. Osorio and Mariana Fleig** 325
Nidulispora gen. nov., a hyphomycete genus with crateriform conidia. **A. Nawawi and A. J. Kuthubutheen** 329
A preliminary checklist of the Agaricales of Tulsa County, Oklahoma. **Estelle Levetin, Nora Jones, and Kerry Owens** 337
Teleomorph-anamorph connections and correlations in some *Xylaria* species . . . . **Brenda E. Callan and Jack D. Rogers** 343
First record of *Catenaria auxiliaris* in Illinois. **C. M. Stiles, D. A. Glawe, and G. R. Noel** 371
Halophytophthora, gen. nov., a new member of the family Pythiaceae. **H. H. Ho and S. C. Jong** 377
A monograph of the discomycete genus *Strossmayeria* (Leotiaceae), with comments on its anamorph, *Pseudospiropes* (Dematiaceae). **Teresita Iturriaga and Richard P. Korf** 383
Nomenclature and synonymy of *Stereum spadiceum* var. *plicatum*. **A. B. De** 455
Phoma proboscis sp. nov. pathogenic on *Convolvulus arvensis*. **Dana Kelly Heiny** 457
Taxonomical studies on Ustilaginales. V. . . . . **Kálmán Vánky** 473
Book Reviews . . . . **G. L. Hennebert** 483
NOTICES:
- Fourth International Mycological Congress: Second Circular 493
- XI Congress, International Society for Human and Animal Mycology . . 494
- Subscription price increase 495
- Important change in editorial policy requiring submission of reviewers' comments 496

[CONTENTS continued overleaf]

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[CONTENTS continued from front cover]

Author INDEX 497
INDEX to Fungous and Lichen Taxa 499
Reviewers 511
Publication Dates, MYCOTAXON Volume 35(2), 36(1) 511
Errata 512

[MYCOTAXON for October-December 1989 (36: 1-311)
was issued November 21, 1989]

MYCOTAXON

Vol. XXXVI, No. 2, pp. 313-323 January-March 1990

ENTOLOMATACEAE IN EASTERN NORTH AMERICA I: new species of Claudopus and Rhodocybe from the Southern Appalachian Mountains.

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SUMMARY: Two new species are described, Rhodocybe pallida and Claudopus vinaceocontusus. A study of the micromorphological features of the type collection of Claudopus mephiticus is presented and discussed because of its similarity in stature and odor to C. vinaceocontusus.

The Southern Appalachian Mountains offer a rich plant and fungal biota. In particular, members of the Entolomataceae Kot. & Pouz. (Agaricales, Basidiomycota) are particularly well represented in this region. Hesler (1967) published a floristic study of the agaric genus *Entoloma* (Fr.) Kummer (Entolomataceae) for the southeastern United States in which he treated approximately 200 taxa. By far, the majority of these species were found in the Appalachian Mountain regions. In addition, and of even greater significance, nearly 50% of the taxa in Hesler's publication were described as new to science. Since that time no other accounts of new members of this family from this area have appeared in the literature.

During a recent study of the Entolomataceae in selected areas of the southeastern United States, two undescribed species were discovered in the Southern Appalachian Mountains. The following report describes these new taxa and discusses their relationships and placement in the family.

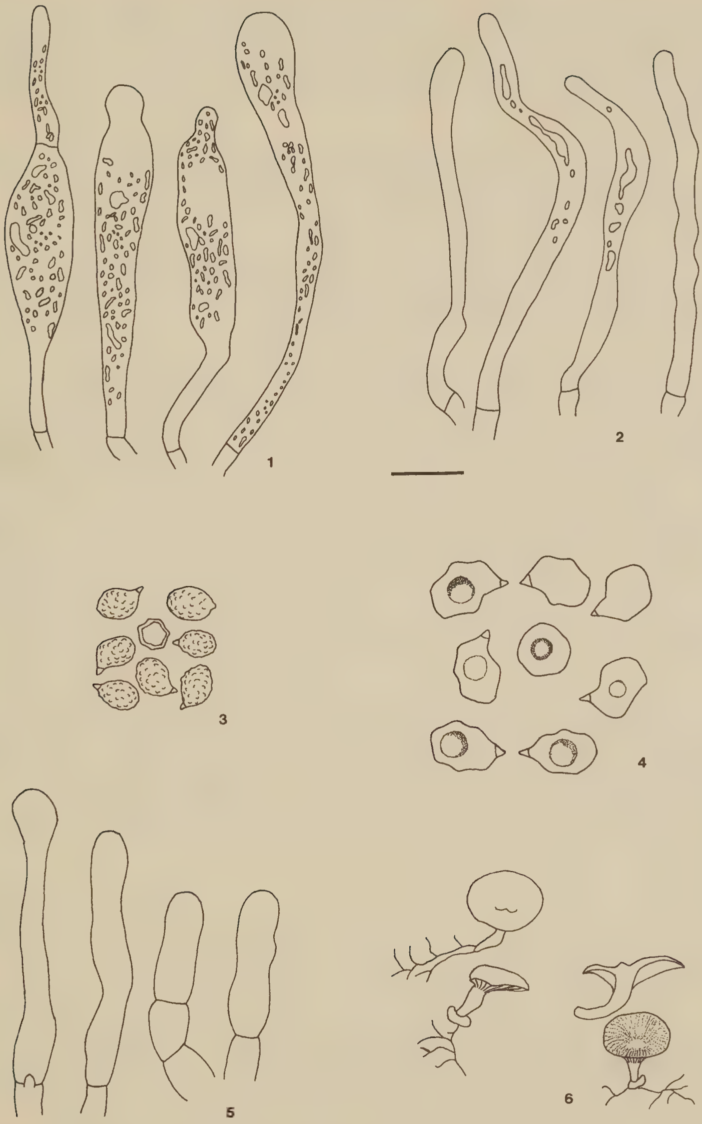
Methods used were those of Baroni (1981). Color designations are from Kornerup and Wanscher (1978). All measurements of microscopic structures were made in 3% KOH. The following notations are used: E = length/width of individual spores, indicated as a range in n spores measured; E^m = mean of E; L^m = mean length; W^m = mean width; n = number of objects measured; *L in 180 deg = 9*, signifies that 9 lamellae are attached to the stipe over one-half of its circumference, implying that there are generally 18 lamellae per mature pileus.

Rhodocybe pallida Baroni, sp. nov. (Figs. 1-3 and 12-13)

Pileus cremeus vel pallide griseo-bubalinus, 9-13 mm latus, convexus, demum depressus, glabrescens, laevis interdum rimulosus. Lamellae subdecurrentes, griseo-bubalinae, confertae, angustae. Stipes glabrescens, cum pileo concolor. Basidiosporae ellipsoidae vel ovoidae, aliter typicae enim Rhodocybes. Cheilo- et pleurocystidia similia, pseudocystidiorum instar, contentis aureo-ochraceis, versiformia, interdum prominentiis cylindricis ad basim septatis. Hyphae pileipellis filmaentosae, repentes, haud incrustatae. Hyphae efibulatae.

Pileus pale sordid cream (near 4A2 but with a slight grayish hue) to pale grayish buff, some with irregularly patterned yellowish (4A3-4) shallow cracks, not changing color when bruised; 9-13 mm broad, broadly convex, becoming shallowly depressed over disc, dry, mat to glabrescent, smooth or with shallow random cracks; margin inrolled. Flesh white, solid, 1 mm thick. Odor not distinctive. Taste mild. Lamellae grayish buff, short decurrent, narrow (to .75 mm broad), close, edges concolorous and even. Stipe concolorous with pileus or with more obvious cream yellow (4A3) over lower 1/3, with a sparse white mycelioid covering over base, 17-20 mm long, 1.5-2.5 mm thick, equal, terete, central; surface dry, glabrescent or merely fine appressed fibrillose over apex and less so toward base; solid and white within.

Basidiospores 5.4-7.2 x 3.6-5 μm ($E = 1.26\text{-}1.67$, $E^m = 1.48$, $L^m = 6.11$, $W^m = 4.16$, n = 20), short ellipsoid to ovoid in lateral views, rounded angular in polar view, with low but distinct undulate-pustulate ornamentation, ornamentation obscure on largest spores; walls thin and often readily collapsing, strongly and continuously cyanophilic, hyaline in KOH, inamyloid. Basidia 19.8-27 x 5.4-7.2 μm, 4-sterigmate with some rarely 1-sterigmate, narrowly clavate, lacking cyanophilic bodies; thin-walled or rarely thick-walled. Cheilocystidia and pleurocystidia (pseudocystidia) similar, 28.7-59 x 6.3-8.1 μm, thin-walled, variable but often clavate to broadly ventricose rostrate to lageniform, apical cylindric proliferations often septate at their base; arising mostly from the subhymenium or trama; contents sparse to dense and granular, shiny refractive, deep golden to reddish ochre in KOH. Lamellar trama of parallel, cylindric to mostly inflated hyphae, 3.6-14.4 μm in diam, with scattered undulate, golden oleiferous hyphae also present; subhymenium composed of a narrow band, 9-13.5 μm thick, of tightly interwoven, narrow, cylindric hyphae, 2.7-3.6 μm in diam. Pileal context of loosely interwoven, cylindric hyphae, 2.7-9 μm in diam. Pileipellis a compact, hyaline or pale melleous layer in KOH, not well-differentiated from the context; hyphae repent, interwoven, cylindric, 2.7-5.4 μm in diam, not encrusted. Stipitipellis a compact hyaline layer of repent, parallel, non-



Figs. 1-3: *Rhodocybe pallida* (HOLOTYPE). 1. Hymenial pseudocystidia. 2. Caulocystidia. 3. Basidiospores. Figs. 4-6: *Claudopus vinaceocontusus* (HOLOTYPE). 4. Basidiospores. 5. Caulocystidia. 6. Basidiomata (x1.5). Scale bar = 10 m.

encrusted, cylindric hyphae, 1.8-3.6 µm in diam, producing scattered clusters of caulocystidia at the apex. Caulocystidia composed of entangled, erect, cylindric end cells, 42.3-73 x 2.7-4.5 µm, with 30-50% of these cells containing shiny golden amorphous bodies in KOH. Clamp connections absent.

Terrestrial under mixed hardwoods (*Fagus grandifolia* Ehrh., *Tilia* sp., *Carya* sp., *Quercus rubra* L., *Liriodendron tulipifera* L., etc.) and *Pinus strobus* L. and *Tsuga canadensis* (L.) Carr.

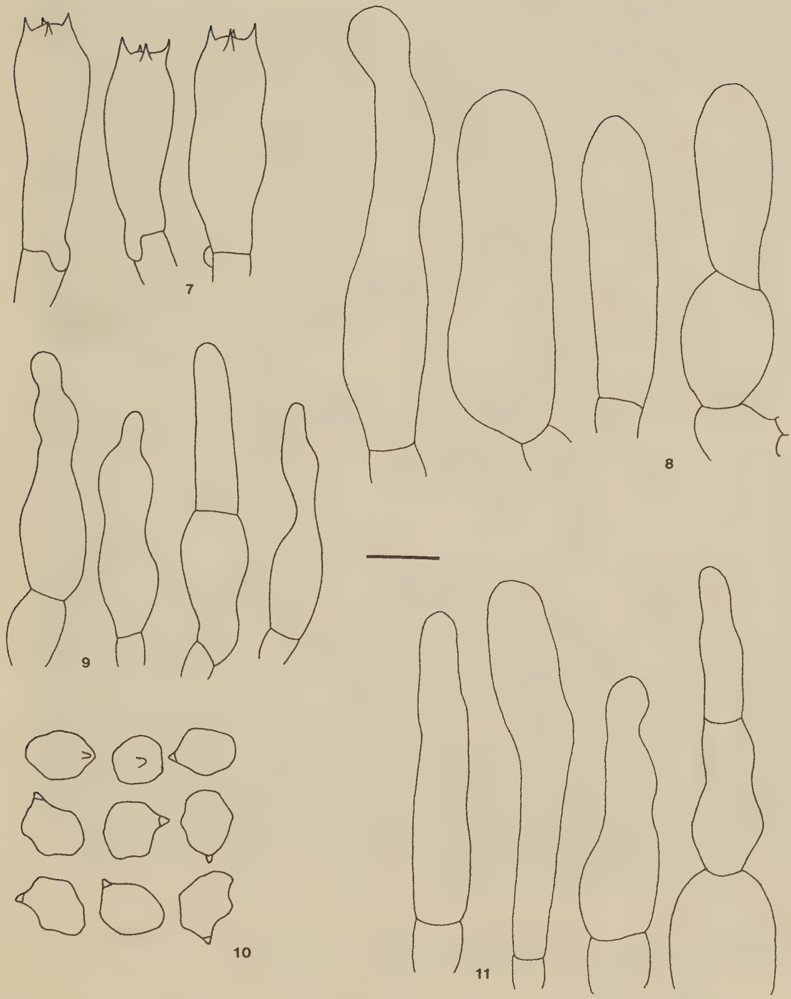
Type: UNITED STATES. North Carolina. Swain Co.: Great Smoky Mountains National Park, Indian Creek, 29 July 1987, Baroni 5596 (leg. D. Desjardin) (HOLOTYPE: TENN)

Rhodocybe pallida belongs in section *Rhodocybe* due to its distinctive basidiospore morphology, hymenial pseudocystidia with brightly colored content, lack of clamp connections and centrally stipitate basidiomata. This particular species is unusual in the section because of its pale colors. At the present time, only one other species in section *Rhodocybe*, *Rhodocybe retroflexa* (Berk. & Br.) Pegler, is known to produce pale cream buff basidiomata. However, *R. retroflexa* can be distinguished by its lignicolous habitat, brownish tinted pileus disc, adnexed lamellae, subangular spores in profile view and pseudoparenchymatous subhymenium (Pegler, 1977). In addition, *R. retroflexa* is known only from the type locality of Peradeniya, Sri Lanka.

There are now 26 species described in section *Rhodocybe* world wide. Recently, following a revision of *Rhodocybe* (Baroni, 1981), a number of investigators have contributed to our knowledge of this section (Halling and Baroni, 1985; Horak, 1978, 1979, 1980; Noordeloos, 1979; Ovrebo and Baroni, 1988; Baroni and Horak, in preparation). A revised key to this section of *Rhodocybe* will be published in the near future.

Claudopus vinaceocontusus Baroni, sp. nov. (Figs. 4-6 and 14)

Pileus sordidus pallide griseo-bubalinusve, purpurascens ubi contusus, 2-10 mm latus, convexus, circularis vel dimidiatus, sericeus. Contextus purpurascens. Odor pungens, dysodes. Lamellae adnatae vel subdecurrentes, pallide carneae, latae. Stipes cum pileo concolor, eccentricus, 3-5 mm longus, 1-2 mm crassus, pubescens, rhizoideis e basi ramosis, ubique purpurascens ubi contusus. Basidiosporae angulatae. Cystidia nulla. Hyphae pileipellis filamentosae, repentes, haud incrustatae. Hyphis dispersis fibulatis.



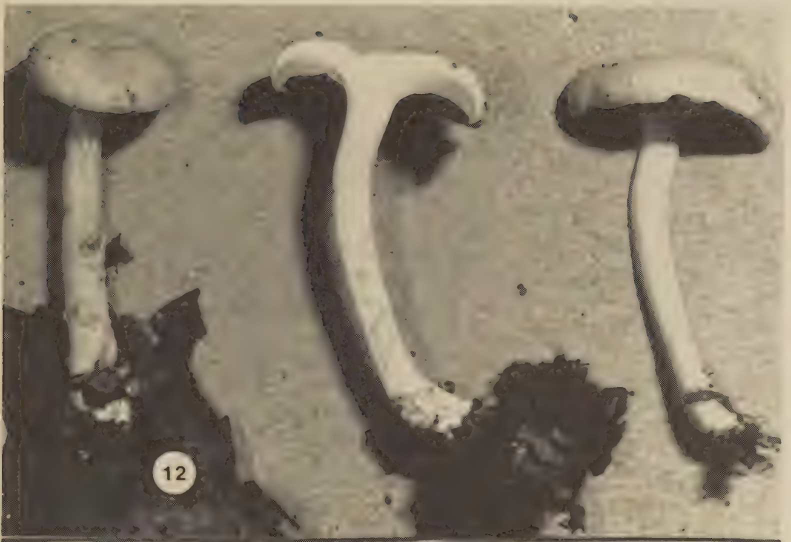
Figs. 7-11: *Claudopus mephiticus* (HOLOTYPE). 7. Basidia. 8. Caulocystidia. 9. Cheilocystidia. 10. Basidiospores. 11. Pilocystidia. Scale bar = 10 μm.

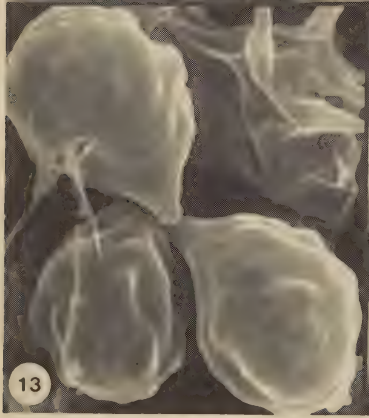
Pileus sordid off white to pale grayish buff (much paler than 5B2), turning quickly light vinaceous when bruised (drying a dark reddish brown); 2-10 mm broad, convex to broadly convex, with a shallowly depressed and low papillate disc, circular to ± dimidiate on some, dry, densely radiate sericeous or appressed fibrillose, the fibrils turning vinaceous when bruised, margin inrolled. Flesh dingy whitish, quickly becoming vinaceous-purple when exposed and then rapidly fading, 0.2-0.5 mm thick. Odor strong of garlic, especially when basidiomata kept enclosed in collecting packet for a short time. Taste not tested. Lamellae pallid at first, soon fleshy pink, adnate or becoming short decurrent, broad (to 1 mm broad), subdistant (L in 180 deg = 9), 2-3 tiers lamellulae, occasionally forked, edges concolorous, even. Stipe concolorous with pileus, 3-5 mm long, 1-2 mm thick at apex, mostly tapered downwards or equal, eccentric; surface dry, densely whitish fibrillose to erect pubescent overall, white mycelioid at base in a pad-like mat, with thin white rhizoids radiating out through substrate, basal covering and rhizoids rapidly turning bright vinaceous-purple when bruised; context solid, white, but rapidly bright vinaceous-purple when exposed, then fading.

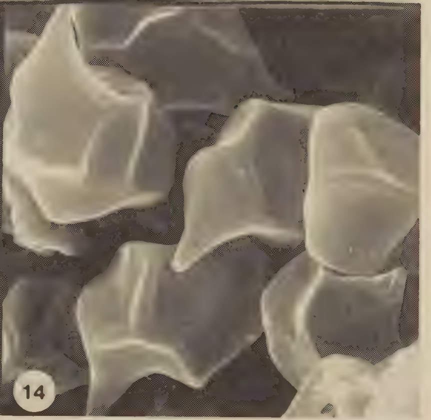
Basidiospores (8.1-)9.5-10.8 x 6.3-7.2 µm (E = 1.25-1.67, E^m = 1.48, L^m = 9.68, W^m = 6.56, n = 21 from the Holotype; 8.5-10 x 6-7.5 µm, E = 1.23-1.54, E^m = 1.38, L^m = 9.38, W^m = 6.79, n = 12 from DAOM 194866), ellipsoid in lateral view with 6-8 sharp or rounded angles, 5-6 rounded angular in polar view; walls strongly cyanophilic. Basidia 26.1-31.4 x 9-9.9 µm, 4-sterigmate, short broad clavate; filled with diffuse vinaceous pigment in H_2O or KOH mounts (especially evident in polar views). Hymenial cystidia not differentiated. Lamellar trama of ± parallel, cylindric to inflated hyphae, 3.6-18 µm in diam. Pileal context of radially arranged, mostly inflated hyphae, 9.9-18 µm in diam, and with some intermixed cylindric hyphae, 2.7-5.4 µm in diam; pale vinaceous in KOH. Pileipellis a repent, hyaline layer of radially arranged to interwoven, cylindric hyphae, 2.7-9 µm in diam, not encrusted, end cells cylindric to subclavate or some bullet shaped. Stipitipellis a compact hyaline layer of repent, parallel, non-encrusted, cylindric hyphae, 2.7-8.1 µm in diam, producing numerous caulocystidia. Caulocystidia mostly cylindric or cylindric-capitate, 15.3-38.6 x 4.5-6.3 µm, hyaline in KOH. Clamp connections present at base of basidia, on hyphae of lamellar trama, widely scattered on stipe surface.

On moss covered log in mixed hardwoods (Holotype), or scattered on a sandy loam soil along a bank.

Type: UNITED STATES. North Carolina. Macon Co.: Coweeta Hydrologic Research Station, along Ball Creek Road, 13 August 1987,







Figs. 12-13: *Rhodocybe pallida* (HOLOTYPE). 12. Basidiomata (approx. x2). 13. Basidiospores (approx. x6,000). Fig. 14: *Claudopus vinaceocontusus* (HOLOTYPE), basidiospores (approx. x3,500).

Baroni 5695 (leg. D. Desjardin) (HOLOTYPE: TENN). Florida. Alachua Co.: vicinity of Gainesville, 9 August 1985, DAOM 194866 (S. A. Redhead 5144)

Claudopus vinaceocontusus is easily distinguished by its small size, strong odor of garlic and by the obvious vinaceous-purple color change of most parts of the basidiomata when they are injured. *Claudopus mephiticus* Murr. is also reported with a decided garlic odor (and taste) (Murrill, 1915 and 1917; Hesler, 1967), but the basidiomata have much larger dimensions with the pileus ranging from 15-50 mm in diameter, the pileus is pale greenish at first, there are no color changes of the flesh upon injury, and cheilocystidia are present in the hymenium (Hesler, 1967). Each of these characters reported for *C. mephiticus* is distinctly different from those found on *C. vinaceocontusus*. However, because of the similar and very unusual garlic odor shared by *C. vinaceocontusus* and *C. mephiticus*, a decription of the latter is given below. The following macroscopic description in quotes is from the original by Murrill, while the microscopic description (not in quotes) and illustrations are from a recent study of the holotype of *C. mephiticus*.

Claudopus mephiticus Murr., MYCOLOGIA 7:290. 1915.

≡ *Entoloma mephiticum* (Murr.) Hesler, Beih. Nova Hed. 23:14. 1967.

(Figs. 7-11)

"Pileus eccentric, convex to nearly plane, somewhat depressed at the center, cespitose, 2.5-5 cm broad; surface dry, glabrous, slightly concentrically sulcate, greenish-white when young, dull-white or yellowish-white when old, margin concolorous, undulate; context white, with a very decided mephitic or garlic odor and taste; lamellae sinuate, subdistant, broad, slightly serrate on the edges, white, becoming rose-colored at maturity; spores angular, rose-colored, uniguttulate, 9 x 7 μ; stipe short, subcylindric, very eccentric, solid, pruinose, white, 1-1.5 cm. long, 4-6 mm. thick."

Basidiospores (8)9-10.8 x 6.3-7.2 μm (E =1.13-1.5, E^M = 1.33, L^m = 9.41, W^m = 7.06, n = 20), 5-6 angled in lateral views, 5-6 rounded angles in polar view, walls cyanophilic on younger spores, less reactive or acyanophilic on older spores. Basidia 24.3-32.4 x 8.1-11.7 μm, 4-sterigmate, broadly clavate, a few with scattered irregular sized, cyanophilic bodies. Cheilocystidia scattered along the edges, cylindric to cylindric-capitate or ventricose-rostrate, otherwise versiform, occasionally septate and/or occasionally with distinctly constricted apices on rostrate forms, thin-walled, hyaline, 30-81 x 7.2-13 m. Pleurocystidia absent. Lamellar trama of parallel to interwoven, cylindric to inflated hyphae, 3.6-9 µm in diam; subhymenium pseudoparenchymatous-like, but truly of tightly interwoven cylindric hyphae, 4.5-8.1 µm diam. Pileal context of radially arranged, mostly inflated hyphae, 2.7-18 µm diam. Pileipellis an entangled layer of cylindric, hyaline hyphae, 6.3-11.7 µm in diam, not well-differentiated from the context, but with widely scattered, narrow, finely incrusted hyphae; end cells repent or entangled ascending, ± cystidioid and mostly cylindric, 34.1-81 x 6.3-11.7 µm. Stipitipellis an entangled to repent layer of parallel, non-incrusted, cylindric to inflated hyphae, 3.6-18 µm in diam, producing repent to occasionally projecting end cells (caulocystidia). Caulocystidia clavate or irregularly swollen, 29.6-63 x 6.3-18 µm, hyaline. Clamp connections abundant at base of basidia, scattered to infrequent in subhymenium and hyphae of lamellar trama.

On fallen dead branches.

Type: UNITED STATES. Minnesota. Minnehaha Park, 30 July 1915, M. W. Smith (M. S. Whetstone 60) (HOLOTYPE: NY).

It is obvious that *C. mephiticus* is not similar to *C. vinaceocontusus* in either macroscopic or microscopic features. In addition, I concur with Hesler's description of the microscopic features for *C. mephiticus* in the sense that this species does possess "hyphoid" pilocystidia (Hesler, 1963). However, Hesler was unable to demonstrate cheilocystidia for the type collection, even though he describes this feature for his collection from Tennessee. Obviously the type of *C. mephiticus* possesses distinctive cheilocystidia (see Fig. 9), but these structures were collapsed and needed to be carefully reinflated using the techniques of Bas (1969 - these techniques deserve careful consideration by all individuals who study type materials). Unfortunately, Hesler's unpublished notes distinctly indicate that his Tennessee collection obviously lacked a stipe. After examining his collection (Hesler TENN 25656), which now consists of approximately 1/4 of a pileus with lamellae, it can only be stated that Hesler's collection is not *C. vinaceocontusus*. However, because of the odor, taste, spore size, cheilocystidia and restricted presence of clamp connections at the base of the hymenial elements (my observations on TENN 25656), Hesler's collection is close to *C. mephiticus*.

At the present time in *Claudopus*, it seems injudicious to expand species concepts to include entities which may possess well-developed stipes on some mature basidiomata and at the same time lack any form of stipe on other mature basidiomata. Until such a case of morphological plasticity in stipe production has been positively shown for this species, or at least in the genus, it must be assumed that Hesler's collection (TENN 25656) represents yet another undescribed mephetic species of *Claudopus*. This species (TENN 25656) certainly needs to be recollected from the type local and redescribed. I consider the present material too meager to be useful enough to serve as a holotype. Therefore, contrary to Hesler's (1967) report, *C. mephiticus* is still only known from the type locality in Minnesota, USA in North America.

ACKNOWLEDGEMENTS

This work would not have been possible without grants from the University of Tennessee under the auspices of the L. R. Hesler Visiting Professorship in Botany, and from the Highlands Biological Research Station. The two new species described herein must ultimately be attributed to the collecting acumen of Dr. Dennis Desjardin, his keen sense of finding the unusual deserves recognition. Dr. Roy Halling kindly arranged for the loan of *Claudopus mephiticus* Murrill. Dr. D. P. Rogers corrected the latin diagnoses, his expertise is sincerely appreciated. Both Drs. Halling and Rogers helped to improve this work by kindly providing critical presubmission reviews. Ms. Dawn Van Hall, photographic department SUNY - College at Cortland, produced black and white negatives from the original color photographs of specimens. The use of the SEM facilities at the Center for Ultrastructural Studies, Environmental Science and Forestry College - SUNY at Syracuse, is also gratefully acknowledged.

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CONTRIBUTION TO THE LICHEN FLORA OF BRAZIL. XXIV.
LICHENS FROM NOVA PETROPOLIS, RIO GRANDE DO SUL STATE.*

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ABSTRACT: Twenty two lichens collected in the Municipality of Nova Petropolis, Rio Grande do Sul State, Brazil, are listed. Two species are added to the State flora and six to the Rio Grande do Sul Higlands lichen flora.

In this paper the authors listed twenty two lichens collected in the Municipality of Nova Petropolis as an additional contribution to the study of this group in the Highlands of Rio Grande do Sul, Brazil. The area visited, during April 1988, is placed 4 km N from Nova Petropolis City (29°22'S-51°08'W, alt. ca. 600 m) along the road BR 116 which connects this City with Caxias do Sul City. The collection sites (very close one from another) can be briefly described as follows:
CASCATA DO RASCHE (CR): a small waterfall surrounded by a very dense shrubby vegetation.
PIA (P): is a place well known through its dairy industry. The gatherings were made in the slope of a small hill with numerous boulders partially shaded by shrubs and low trees.
Two identical series were made with the lichens gathered and deposited in the Herbarium of the Departamento de Botanica, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil and in the private herbarium of the senior author.

Buellia contiguella (Vain.) Malme
P: on rocks (88/70).
Caloplaca crocea (Kreplh.) Haf. & Poelt
P: on trunk of a isolated tree (88/72).
Cladonia ceratophylla (Sw.) Spreng.
P: on rocks (88/51).
Dictyonema glabratum (Spreng.) D. Hawksw.
P: on rocks (88/53).
Diploschistes cinereocaesius (Sw. ex Ach.) Vain.
P: on perpendicular rocks (88/58) det. H. T. Lumbsch

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Heterodermia lutescens (Kurok.) Follm.
CR: on trunk of shrubs (88/48.a.).
P: on mossy rocks, shaded place (88/68).

Heterodermia vulgaris (Vain.) Follm. & Redón
CR: on trunk of shrubs (88/48.b.).

Lecidea oreinodes (Körb.) Weber & Hertel
P: on rocks (88/52).

Leptogium cyanescens (Ach.) Körb.
P: on mossy rocks (88/69).

Parmelina muelleri (Vain.) Hale
CR; on trunk of shrubs (88/47). Known in the State from only one collection made in the Central Lowlands (Osorio et al. 1980:5).

Parmotrema mellissii (Dodge) Hale
P: on rocks (88/73).

Parmotrema reticulatum (Tayl.) Choisy
P: on rocks (88/63).

Parmotrema tinctorum (Nyl.) Hale
P: on rocks (88/60).

Peltigera austroamericana Zahlbr.
P; rocks, shaded place (88/50).

Pseudocyphellaria aurata (Ach.) Vain.
CR: on trunk of shrubs (88/46).
P: on trunk of a tree (88/66).

Pseudoparmelia caroliniana (Nyl.) Hale
P; on rocks with mosses and *Polypodium* (88/56, 88/64).

Pseudoparmelia texana (Tuck.) Hale
P: on rocks (88/61).

Punctelia constantimontium Sérus.
P: on rocks with mosses and *Polypodium* (88/67).

Ramalina celastri (Spreng.) Krog & Swinsc.
CR: on branches of shrubs (88/49).
P: on branches of shrubs (88/74).

Relicina abstrusa (Vain.) Hale
P: on perpendicular rocks, shaded place (88/59). Formerly known from the Municipality of Cambara do Sul, in the north eastern part of Rio Grande do Sul Highlands (Fleig 1985:86).

Sticta weigelii (Ach.) Vain.
P.: on rocks with mosses and *Polypodium* (88/54).

Xanthoparmelia farinosa (Vain.) Nash, Elix & Johnston
P: on rocks (88/62, 88/71).

RESULTS AND CONCLUSIONS.

The Municipality of Nova Petropolis, situated ca. 75 km N from Porto Alegre City, is unknown from a lichenological point of view. No records could be found in the literature at our disposal.
The results of the study of the lichens gathered are as follows:

a) *Buellia contiguella* and *Diploschistes cinereocaesius* are added to the known flora of the State.
b) *Buellia contiguella*, *Diploschistes cinereocaesius*, *Heterodermia lutescens*, *Parmelina muelleri*, *Punctelia constantimontium* and *Xanthoparmelia farinosa* are reported to the Rio Grande do Sul Highlands for the first time.
c) The remaining listed species have been already quoted from Rio Grande do Sul Highlands in former contributions of the authors.

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NIDULISPORA GEN. NOV., A HYPHOMYCETE GENUS WITH CRATERIFORM CONIDIA

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A new genus **Nidulispora,** based on the new species **N. quadrifida** isolated from submerged decaying twigs in Malaysia is described and illustrated. It is compared with several other hyphomycetes with composite conidia.

In our continuing studies on microfungi inhabiting submerged decaying plant litter from freshwater streams in Malaysia, it is by no means uncommon to find on such substrates microfungi which by their often bizarre pecularities, are immediately recognised as distinct genera, e.g. **Satchmopsis** (Sutton, 1975), **Beverwykella** (Tubaki, 1975a, Nawawi & Kuthubutheen, 1988) and **Cancellidium** (Tubaki, 1975b, Webster & Davey, 1980) to name a few. The fungus described below as **Nidulispora quadrifida** falls in this category.

Nidulispora gen. nov.

Coloniae sparsae, late effusae. Mycelium plerumque superficiale sed in substrato immersum, ex hyphis pallide brunneis vel brunneis, laevibus vel verrucatis, septatis compositum. Conidiophora semimacronematosa, mononematosa, erecta, brevia, ex mycelio superficiali terminalia et lateralia oriunda. Cellulae conidiogenae integratae, terminales, holoblasticae, singulae in quoque conidiophora. Conidia solitaria, sicca crateriformia, e aliquot cellulis basali constantia et ramis dichotomis ramosis, euseptatis; apicem versus pallidiora curvata composita.

Species typica: Nidulispora quadrifida sp. nov.

Colonies sparse, widely effuse. **Mycelium** mostly superficial, partly immersed in the substratum, composed of pale brown to brown, smooth to verruculose, branched, septate hyphae. **Conidiophores** semi-macronematous, mononematous, erect, short, arising terminally and laterally from the superficial mycelium. **Conidiogenous cells** integrated, terminal, holoblastic, single on each conidiophore. **Conidia,** solitary, dry, crateriform, with several dichotomously branched, euseptate, attentuated, curved ascending arms arising from several basal cells.

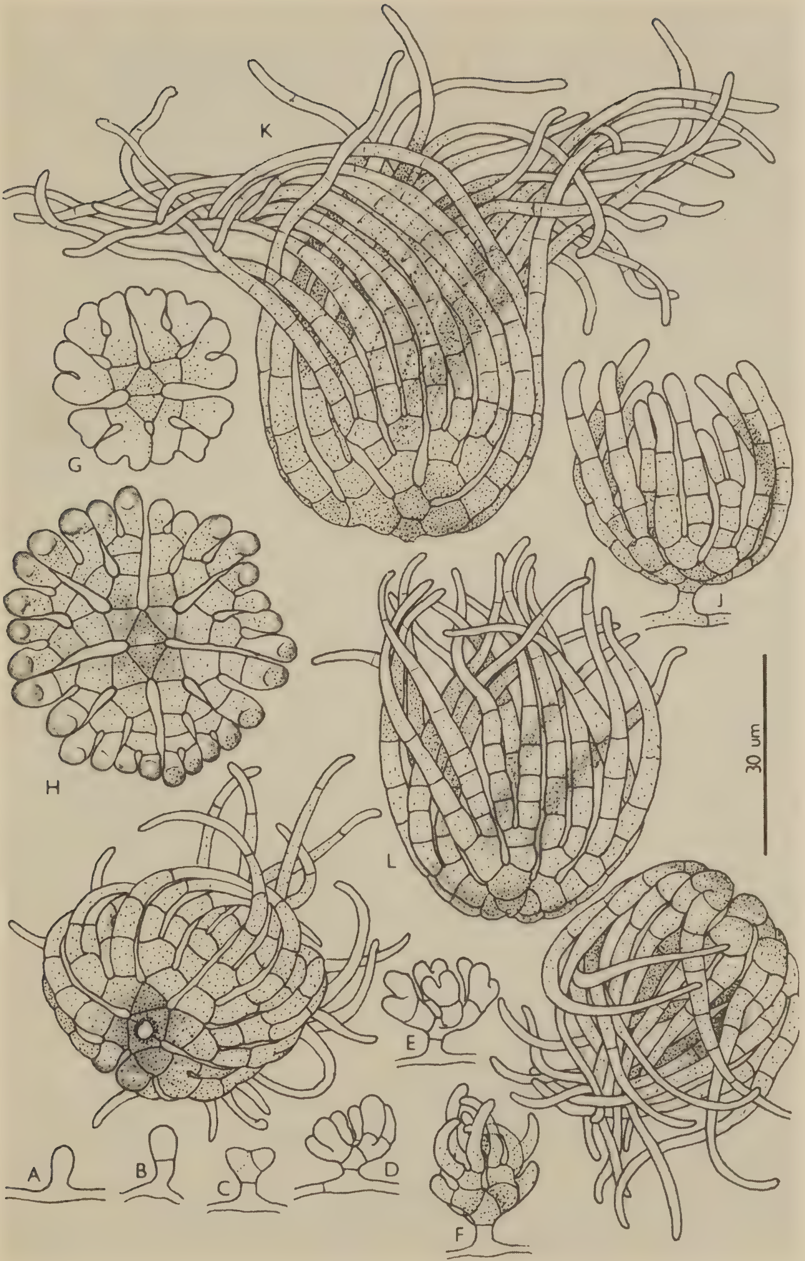
Nidulispora quadrifida sp. nov. Figs. 1 - 2

Coloniae sparsae, late effusae. Mycelium plerumque superficiale sed in substrato immersum, ex hyphis pallide brunneis, laevibus vel verrucatis, septatis, immersis compositum, ex quibus exoritur reticulum hypharum superficialum brunnearum, ramosarum, septatarum 2 - 3 µm diam. Conidiophora semimacronematosa, mononematosa, brevia, 10 - 15 µm x 2.5 - 3.5 µm, brunnea, ex mycelio superficiali terminalia et lateralia oriunda. Cellulae conidiogenae integratae, terminales, holoblasticae, singulae in quoque conidiophora. Conidia solitaria, sicca, crateriformia, 32 - 52 µm x 40 - 60 µm, e aliquot cellulis basali constantia et 18 - 32 ramis dichotomis ramosis, 5 - 7 euseptata, apicem versus pallidiora, curvata composita. Conidiorum secessio schizolytica.

In ramunculus emortuos ignotes, Bukit Rengit Forest Reserve, Pahang, Malaysia, Oct., 1988, A.J. Kuthubutheen IMI 334130, holotypus.

Colonies sparse, widely effuse. **Mycelium** mostly superficial but partly immersed in the substratum, composed of pale brown to brown, branched, septate immersed hyphae giving rise to a network of brown, smooth to verruculose, sparsely branched, septate, superficial 2 - 3 µm wide hyphae. **Conidiophores** semimacronematous, mononematous, short 0 - 2 septate, up to 10 - 15 µm high x 2.5 - 3.5 µm wide, arising terminally and laterally from the superficial mycelium. **Conidiogenous cells** integrated, terminal, holoblastic, single on each conidiophore. **Conidia** solitary, dry, crateriform, 32 - 52 µm wide, 40 - 60 µm high, brown below, becoming lighter above, consisting of a small basal cell 4 - 5 µm wide, 5 - 6 µm high, merging into a 6-celled basal plate from which arises 18 - 32 dichotomously branched, 5 - 7 euseptate, curved, attentuate arms, encircling a hollow, air-filled space. **Conidial secession** schizolytic.

Fig. 1. **Nidulispora quadrifida.** A-F, Stages in conidial formation on agar; G-J, conidial formation and maturation on twigs; K-L, mature conidia.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Many conidia at various stages of development were examined on the decaying twigs, and from these it was easy to build up in detail a picture of conidium development. This picture was later confirmed by observations on the course of individual conidium development. On the natural substrate the conidium starts as a swollen cell at the end of a short conidiophore. It swells somewhat and the apex branches dichotomously and soon two oblique septa are formed, dividing the conidium initial into a 3-celled structure. The lower cell, measuring 4 - 5 µm long, 5 - 6 µm wide remains as the basal cell while the other two continue to branch dichotomously from their apices. These dichotomous branching occur at least 3 more times leading to the formation of a structure with 32 arms. Septa are laid down with progressive branching and at the same time the arms curve gently upward, forming a bowl-shaped base. The free ends of the arms continue to elongate, curve further inwardly and at the same time become narrower with widely spaced septa. The subhyaline, filiform ends criss-cross over one another, enclosing a hollow space within which air is trapped. In many conidia observed, the arms do not grow straight up but curve to one side. Due to the regular branching pattern the conidium is divided into 4 segments, hence the specific epithet. This is clearly seen when a conidium is viewed from below. Sometimes one-half is more widely separated than the other (Fig. 2) along one axis. Where branching is regular, the conidium is furnished with 32 arms, but this number may be as low as 18. This happens when some of the developing arms stop branching.

Conidia germinate readily on agar media by producing germ tubes from the tips of the arms and from the basal cell. On CMA the colonies are slow growing, attaining a diam of 8 mm in 14 days at 25 - 28°C. Colonies are greyish black with fluffy aerial mycelium, reverse black. Sporulation was poor on dry agar, but occurred abundantly when pieces of colonies were half submerged in water. Conidia are formed on short lateral conidiophores or at the ends of long repent hyphae. Conidia formed in cultures tend to be smaller, many appearing abnormal, with only several arms.

Several hyphomycete genera have been described with composite conidia, some producing very elaborate structure from cup-shaped, umbrella-shaped to globose hollow propagules. Of these there is only one which bears really close relationship with **Nidulispora** and that is the monotypic **Cancellidium applanatum** Tubaki, a common aero-aquatic hyphomycete in Malaysia growing on submerged decaying leaves and twigs. The conidia are broadly

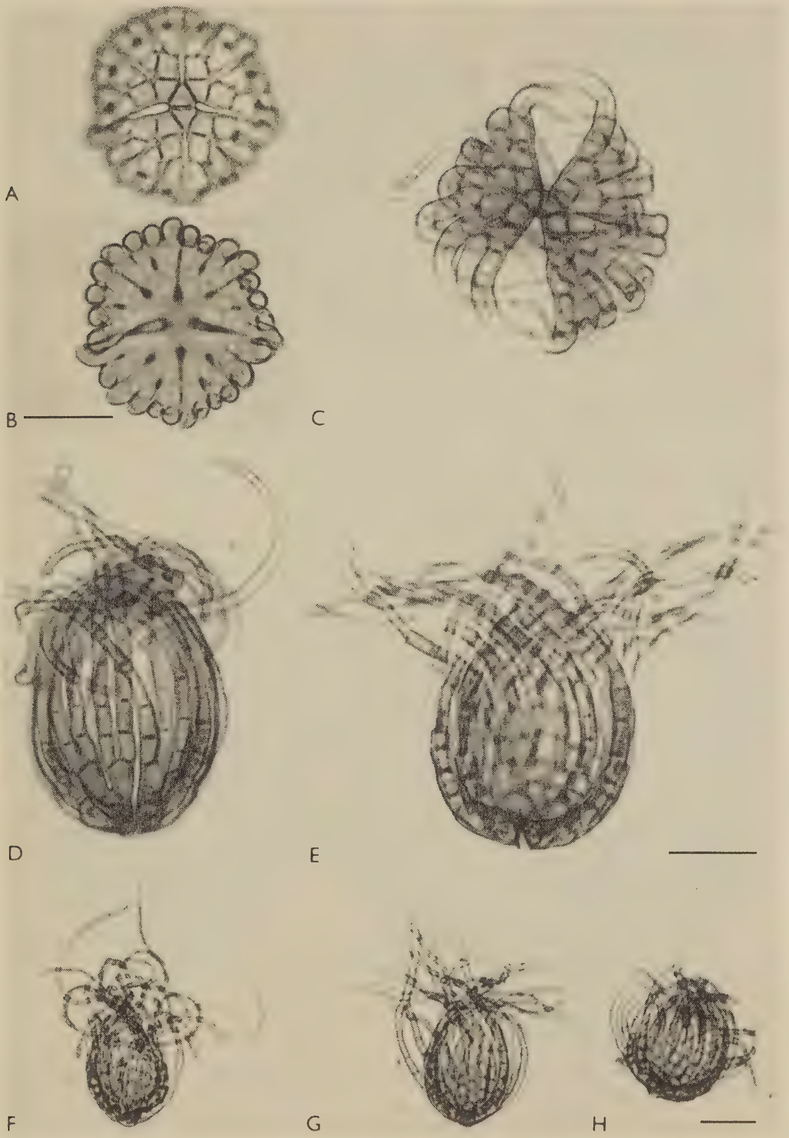

Fig. 2. **Nidulispora quadrifida.** A-B, a developing conidium showing dichotomous branching and segmentation; C-H, conidia from twigs. Bars = 20 µm.

ellipsoidal in surface view, flattened dorsiventrally like a flattened wine-glass. They develop at the apex of short semimacronematous conidiophores by repeated division of the globose conidiogenous cell to form a basal pad consisting of several cells thick. From around the peripheral cells a series of parallel contiguous, finger-like, septate hyphae grows out which finally curve inward to close the hollow structure. At the same time the cells in the centre elongate to produce a series of branched, moniloid chains of subhyaline cells which become enclosed within (Fig. 3). Conidial secession is schizolytic.

Although the conidia in **C. applanatum** and **N. quadrifida** are not entirely dissimilar inasmuch as they consist of several basal cells with many parallelly arranged arms, in detail the two genera differ markedly. In **C. applanatum** the mature conidia are dark brown throughout, and the vertical ascending arms are coherent and adpressed whereas in **N. quadrifida** the arms are formed from at least 2 - 3 series of dichotomous branches or branchings, and they are not coherent and adpressed and their ends are subhyaline, filiform and free.

Conidia of **N. quadrifida** superficially resemble the detached conidia of **Cryptocoryneum** Fckl. and **Cryptocoryneopsis** Sutton (1980) in being composite. In these two genera their conidia consist of several apical, central cap cells with pendulous rather than ascending arms, but when they become detached from their conidiophores there is little to indicate their previous orientation. However, detailed comparison of their conidiogenesis and conidia shows the two genera to be quite distinct from **N. quadrifida** in a number of features.

None of the genera discussed above have conidia in which the arrangements and orientation of the basal cells and the ascending recurved arms are so carefully and regularly ordered as in **Nidulispora quadrifida.**

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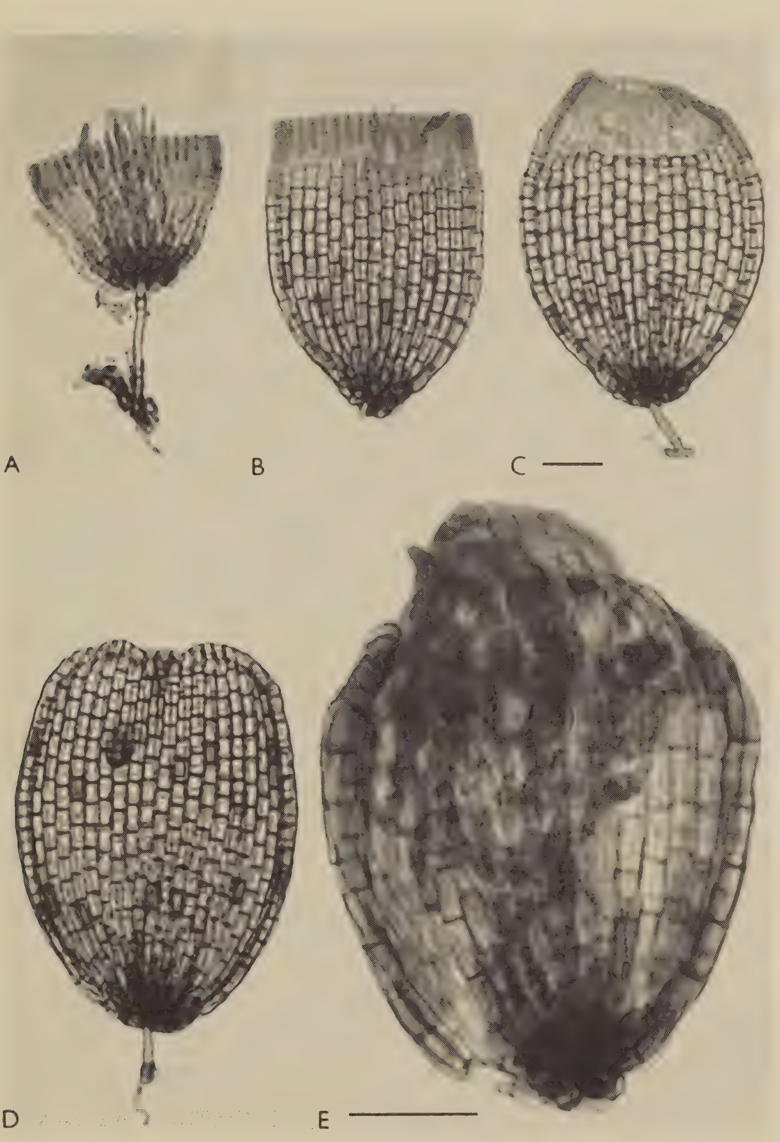

Fig. 3. **Cancellidium applanatum** A-C, three stages in conidial formation from a leaf. D-E, two mature conidia, one in optical section to show the moniliod chain of cells enclosed within. Bars = 20 µm.

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A PRELIMINARY CHECKLIST OF THE AGARICALES OF TULSA COUNTY, OKLAHOMA

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Northeast Oklahoma with its predominantly oak forests supports a diverse agaric flora. Over 100 species, representing 13 families in the Agaricales, are reported from Tulsa County. This checklist establishes ranges extension for many species.

Oklahoma is a state of tremendous floral diversity ranging from the deciduous forests of the eastern part of the state through the grasslands in the central portion to the coniferous vegetation of the Rocky Mountain foothills in the far reaches of the panhandle. Tulsa County in northeast Oklahoma is situated on the boundary between a tall-grass prairie and a post oak-blackjack oak community. Within the county there are many scattered stands of woodland areas that have not been modified by human activity. Tulsa has a mild continental climate with an average of 99 cm of rain per year. The summers are hot and the winters cool; both spring and fall are normally wet with mild temperatures. The climate during the spring and fall is ideal for fungal growth, and mushrooms along with other basidiomycete fruiting bodies are common on lawns and trees, and in fields, parks, and forests.

No thorough taxonomic studies of the fleshy fungi in Oklahoma have been published. Cooke (1983) reported on the fungi collected on August 11, 1979 during a foray of the Mycological Society of America. During that foray, 132 species of fungi were collected including 31 species of basidiomycetes; however, only one species was a member of the Agaricales. Recently Smith and Pfiester (1988) reported on the collection of a single specimen of *Lepiota procera* in leaf litter on a pathway at Lake Thunderbird in central Oklahoma.

For the past two and one-half years a study has been in progress to identify airborne basidiospores along with other allergenic spores from the Tulsa atmosphere. To aid in the identification of basidiospores, field studies have been carried out in conjunction with the air sampling.

Fresh fruiting bodies of basidiomycetes have been collected and identified; spores from these specimens have been used to prepare permanent reference slides (Levetin, 1989). This paper presents a working checklist on the members of the Agaricales which have been collected and identified during this study.

METHODS AND HABITATS

Although the majority of specimens were collected since October 1986, previous field work (from 1972-1986) by the senior author had identified the most common species in the area. Mushrooms were collected from urban and rural wooded areas as well as urban lawns, fields, and parks. Specific wooded areas used as collecting sites include Mohawk Park, Haikey Creek Park, and Turkey Mountain. Mohawk Park, the largest site, is in the northern part of the county. This 2820 acre city park contains a zoo, nature trails, a golf course, and picnic areas as well as extensive tracts of undeveloped woodlands. Both Haikey Creek Park, a county park in the southeastern part of Tulsa County, and Turkey Mountain, an urban wilderness area maintained by the city, contain large stands of wooded areas. Standard collecting techniques were used, and specimens were identified, dried, and housed in the Barclay Herbarium of The University of Tulsa.

RESULTS AND DISCUSSION

A large number of Agaricales occur in Tulsa County. In addition to the 112 species listed in Table 1, many other specimens were identified only to genus level. These are being withheld for further taxonomic study. As a result this report represents only a fraction of the agaric flora that was collected. It should also be pointed out that the focus of this study related to airborne basidiospores as allergens; therefore, the major emphasis was placed on collecting mushrooms from populated urban areas. Additional collecting in rural areas outside the city will significantly expand the list.

The families Amanitaceae and Tricholomataceae are well represented in the Tulsa area. *Amanita vaginata* is widespread in spring and fall in both wooded areas and beneath hardwoods on lawns. Other prevalent species of *Amanita* include *A. inaurata*, *A. virosa*, and *A. rubescens*. Surprisingly, the latter two species were frequently collected in urban areas usually beneath oaks. *Amanita thiersii* can often be found on lawns in late summer; this large *Amanita* with scaly cap and shaggy stalk has previously been reported only from Texas and Mississippi (Jenkins, 1986; Weber and Smith, 1985). Although amanitas form mycorrhizal relationships and are usually found associated with trees (Singer, 1986) *A. thiersii* seems to

322		6	*for*	local	*read*	locality
339	c. 2	31	for	*violaceous*	read	*violaceus*

Table 1. SPECIES COLLECTED IN TULSA COUNTY, OKLAHOMA

AGARICACEAE

Agaricus abruptibulbus Pk.
Agaricus arvensis Schaeff.: Fr.
Agaricus auricolor Krieger
Agaricus campestris L.: Fr.
Agaricus xanthodermoides Murr.

AMANITACEAE

Amanita arkanasana Rosen
Amanita bisporigera Atk.
Amanita citrina (Schaeff.) S.F.Gray
Amanita flavoconia Atk.
Amanita flavorubescens Atk.
Amanita fulva (Schaeff.) Secr.
Amanita inaurata Secr.
Amanita pantherina var. *multisquamosa* (Pk.) Jenk.
Amanita praegraveolens (Murr.) Sing.
Amanita rubescens (Pers.: Fr.) S.F. Gray
Amanita thiersii Bas
Amanita vaginata (Bull.: Fr.) Vitt.
Amanita verna (Bull.: Fr.) Vitt.
Amanita virosa Secr.

BOLBITIACEAE

Conocybe lactea (Lge.) Métrod
Conocybe tenera (Schaeff.: Fr.) Kühner
Agrocybe dura (Bolt.: Fr.) Sing.
Agrocybe pediades (Pers.: Fr.) Fayod

BOLETACEAE

Boletus affinis Pk.
Boletus bicolor Pk.
Boletus fraternus Pk.
Boletus parasiticus Bull.: Fr.
Boletus variipes Pk.
Gyrodon meruloides (Schw.) Sing.
Leccinum rugosiceps (Pk.) Sing.
Strobilomyces floccopus (Vahl: Fr.) Karst.
Tylopilus felleus (Bull.: Fr.) Karst.
Tylopilus indecisus (Pk.) Murr.
Tylopilus pseudoscaber (Secr.) Sm. & Thiers.

COPRINACEAE

Coprinus comatus (Muller: Fr.) S.F. Gray
Coprinus micaceus (Bull.: Fr.) Fr.
Coprinus plicatilis (Curt.: Fr.) Fr.
Coprinus quadrifidus Pk.
Coprinus radicans (Desm.) Fr.
Paneolina foenisecii (Pers.: Fr.) Maire
Panaeolus fimicola (Fr.) Gill.
Panaeolus subalteatus (Berk & Br.) Sacc.
Psathyrella candolleana (Fr.) Maire
Psathyrella hydrophila (Bull.) Maire
Psathyrella velutina (Pers.: Fr.) Sing.
Pseudocoprinus desseminatus (Pers.: Fr.) Kühner

CORTINARIACEAE

Cortinarius alboviolaceus (Pers.: Fr.) Fr.
Cortinarius violaceous (L.: Fr.) Fr.
Crepidotus mollis (Schaeff.: Fr.) Kummer
Gymnopilus fulvosquamulosus Hes.
Inocybe fastigata (Schaeff.: Fr.) Quél.
Inocybe napipes J. Lange

HYGROPHORACEAE

Hygrophorus agathosmus (Fr.) Fr.
Hygrophorus conicus (Fr.) Fr.
Hygrophorus flavescens (Kauff.) Sm. & Hes.
Hygrophorus puniceus (Fr.) Fr.
Hygrophorus russula (Fr.) Quél.
Hygrophorus virgineus (Fr.) Fr.

LEPIOTACEAE

Chlorophyllum molybdites (Meyer: Fr.) Mass
Lepiota americana Pk.
Lepiota procera (Scop.: Fr.) S.F. Gray
Leucocoprinus breviramus H.V. Smith & Weber
Leucocoprinus luteus (Bolt.) Godfrin
Leucocoprinus longistriatus (Pk.) H.V. Smith & Weber

PLUTACEAE

Pluteus cervinus (Schaeff.: Fr.) Kummer
Pluteus pellitus (Pers.: Fr.) Kummer

RHODOPHYLLACEAE

Entoloma clypeatum (L.: Fr.) Kummer
Clitopilus prunulus (Scop.: Fr.) Kummer

RUSSULACEAE

Lactarius chrysorheus Fr.
Lactarius oculatus (Pk.) Burlingham
Lactarius subdulcis (Pers.: Fr.) S.F. Gray
Lactarius volemus (Fr.: Fr.) Fr.
Lactarius yazooensis Hes. & Sm.
Russula compacta Frost
Russula foetens Fr.
Russula virescens Fr.

STROPHARIACEAE

Naematoloma fasciculare (Huds.: Fr.) Karst.
Pholiota erinaceela (Pk.) Pk.
Pholiota subcaerulia Sm. & Hes.
Stropharia coronilla (Bull.: Fr.) Quél.
Stropharia melanosperma (Bull.: Fr.) Quél.

TRICHOLOMATACEAE

Armillariella mellea (Vahl : Fr.) Karst.
Armillariella tabescens (Scop.: Fr.) Sing.
Clitocybe gigantea (Sow.: Fr.) Quel.
Clitocybe nuda (Bull.: Fr.) Bigl. & Sm.
Clitocybe odora (Bull.: Fr.) Kummer
Clitocybe tarda Pk.
Clitocybe umbrinipes Bigl. & Sm.
Collybia dryophila (Bull.: Fr.) Kummer
Collybia maculata (Alb. & Schw.: Fr.) Kummer
Flammulina velutipes (Curt.: Fr.) Karst.
Hypsizygus tessulatus (Bull.: Fr.) Sing.
Laccaria laccata (Scop.: Fr.) Berk. & Br.
Lentinellus ursinus (Fr.) Kühner
Marasmiellus nigripes (Schw.) Sing.
Marasmius capillaris Morg.
Marasmius oreades (Bolt.: Fr.) Fr.
Marasmius rotula (Scop.: Fr.) Fr.
Marasmius siccus (Schw.) Fr.
Melanoleuca meleleuca (Pers.: Fr.) Murr.
Mycena leiana (Berk.) Sacc.
Omphalotus illudens (Schw.) Bresinsky & Besl.
Oudemansiella radicata (Rel.: Fr.) Sing.
Panus rudis Fr.
Panus tigrinus (Bull. ex Fr.) Sing.
Phyllotopsis nidulans (Pers.: Fr.) Sing.
Pleurotus ostreatus (Jacq.: Fr.) Kummer
Rhodotus palmatus (Bull.: Fr.) Maire
Tricholoma columbetta (Fr.) Kummer
Tricholoma virgatum (Fr.: Fr.) Kummer
Tricholomopsis platyphylla (Pers.: Fr.) Sing.
Xeromphalina campanella (Batsch: Fr.) Kühner & Maire

be an exception since it was collected on open lawns. *Amanita praegraveolens*, while not as common as *A. thiersii*, also occurs on open lawns. In the U.S. the genus *Amanita* attains its greatest diversity in the southeastern states (Arora, 1986) with its dominant oak-hickory-pine communities. It appears that the Amanitaceae may be an important part of the agaric flora of the post oak-blackjack oak community in this area as well.

In the Tricholomataceae two species, *Armillariella tabescens* and *Pleurotus ostreatus*, are among the most frequently sighted mushrooms in both urban and wooded areas. *Armillariella* which occurs in the late summer and fall is especially abundant during October. Numerous fruitings can be found on decaying hardwoods throughout the city. *Pleurotus ostreatus* can occur at any time of the year, but is usually encountered in the late fall and winter. Fresh clusters of *P. ostreatus* have been collected in December, January, and February during mild weather. *Flammulina velutipes* has also been collected during the winter and is abundant in spring. *Oudemansiella radicata* is commonly found from the spring through the fall on both urban lawns and in wooded areas. Fruiting bodies of *Clitocybe* and *Tricholoma* species are fairly common, especially in the fall, but many of these require further study for species identification.

In urban areas *Agaricus* and *Coprinus* species are ubiquitous in the spring and fall but can occur virtually year round. They are especially prominent after the sporadic rainy periods of summer. In addition to the species listed, other specimens in these genera have been collected. *Pluteus cervinus* and species of both *Russula* and *Lactarius* are also abundant in late spring and fall on urban lawns as well as wooded areas. After moderate to heavy rains during the summer and fall, *Chlorophyllum molybdites* can be found in large numbers on lawns throughout the city. This mushroom is conspicuous not only because it is abundant but also because of its large size with the cap often reaching 25 cm in diameter.

During late spring and early summer, numerous small ephemeral mushrooms can also be found on lawns amongst the blades of grass. *Agrocybe pediades*, *Conocybe lactea*, *Coprinus plicatilis*, *Marasmius oreades*, *Panaeolina foeniscii* and *Psathyrella* species are the most frequently encountered of these small mushrooms. *Clitocybe tarda*, also found on lawns, is less common but more distinctive because of its slightly larger size and lilac color.

This first report on the Agaricales from northeast Oklahoma represents range extensions of many species and shows that the area supports a rich assortment of fleshy fungi. While some of the mushrooms listed can be found throughout North America, others such as *Armillariella tabescens*, *Chlorophyllum molybdites*, *Omphalotus illudens*, *Tylopilus indecisus, Leccinum rugosiceps,* and *Boletus fraternus* are more common in the South (Weber and Smith, 1985; Lewis and McGraw, 1984). Also *Lactarius yazooensis, Amanita thiersii, A. arkansana*, and *A. praegraveolens* have only been reported in the South (Weber and Smith, 1985, Jenkins, 1986). Clearly, more field work and more taxonomic work needs to be done to fully understand the diversity that is present.

ACKNOWLEDGEMENT

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TELEOMORPH-ANAMORPH CONNECTIONS AND CORRELATIONS IN SOME XYLARIA SPECIES

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ABSTRACT

Cultures and anamorphs of three penzigioid fungi show conclusively that they are, in fact, *Xylaria* species. *Xylaria enteroleuca* had previously been transferred from *Penzigia*. The new combination, *X. atrosphaerica*, is made. A fungus much like *Penzigia indica* is likewise a *Xylaria*, but a new combination is not made owing to differences between the teleomorph of type material from India and our material from South America. Cultures of *X. enterogena* and *X. telfairii* are very similar, reinforcing the concept that these taxa are closely related or perhaps conspecific. Cultures from fungi close to *X. cubensis* and *X. allantoidea* reinforce the impression that these taxa are members of a complicated and poorly understood complex. Cultures from temperate and tropical collections of *X. curta* and *X. microceras*, respectively, are compared. Small differences between temperate and tropical teleomorphs of these two species are reflected in the corresponding cultures, indicating infraspecific variation. *Xylaria arbuscula* and *X. feejeensis* are cosmopolitan species that have been cultured previously. Additional cultural and anamorphic data are presented here. Cultures and anamorphs are described for *X. adscendens* and *X. tentaculata*.

INTRODUCTION

Xylaria Hill ex Schrank is increasingly recognized as a diverse and complicated assemblage of taxa. It has become apparent that the biology and systematics of *Xylaria* and its allies can be understood only after consideration of the holomorphs. Moreover, xylariaceous fungi are frequently implicated as endophytes and cultures usually are sterile or produce only the anamorph. Cultural representatives of the Xylariaceae ordinarily can be identified only after comparison with cultures that originated from identified teleomorphic material. Cultural and other data are presented for 14 Xylarias in order to complement and supplement our understanding of these fungi.

MATERIALS AND METHODS

All cultures were initiated from multiple ascospores dissected from perithecia that had been rehydrated with sterile distilled water. Colonies were incubated on Difco oatmeal agar in 9 cm diam plastic Petri dishes at ca. 20 C and under alternating daily periods of ca. 12 h fluorescent light and 12 h darkness. Conidiophores were usually observed after rolling stromata over a slide previously coated by a thin layer of water-soluble mucilage glue (LePage's brand). Excess conidia were thus pulled off first, allowing for clearer viewing of the conidiogenous cells which were last to be torn from their palisades. The glue is transparent and dissolved after water and a coverslip were added. Measurements of all structures except ascus rings were recorded from specimens mounted in water; the rings were stained with Melzer's iodine reagent. Brightfield (BF) and Nomarski differential interference contrast (DIC) microscope techniques were used.

Specimens deposited in the personal collection of J. D. Rogers are designated JDR.

Xylaria adscendens (Fr.) Fr., Nova Acta Regiae Soc. Sci. Upsal. (ser. 3) 1, p. 128. 1851. Figs. 1-7.

Stromata cylindrical, tapering to pointed, sterile apices, fertile portions 3.5-5.5 cm x 2.5-5 mm, stipes slender, short, sometimes 2 or 3 fused at or near slightly swollen and strigose base, 3-7 mm high x 1-1.5 mm broad. Exterior black, wrinkled and roughened by ostiolar papillae, with remnants of superficial dark brown layer wearing away in longitudinal strips; hollow. Perithecia globose, ca. 0.5 mm diam. Ostioles papillate, surrounded by whitish discs in old specimens. Asci 8-spored, cylindrical, stipitate, spore-bearing portions 70-85 x 4.5-5 μm, stipes 50-60 x 2-3 μm, with apical ring bluing in Melzer's iodine reagent, quadrate, 1.5-2 μm. Ascospores blackish-brown, unicellular, ellipsoid-inequilateral, smooth, 10-10.5(-11) x 4-4.5 μm, with straight, full-length to nearly full-length germ slit.

Colonies reaching edge of Petri dish in 2 wk, at first white, appressed, velvety, with plumose margins, turning canary yellow and darkening from center outwards to olive-black. Centers of colonies frequently becoming covered with cottony mycelium that reaches to the Petri dish lid. Reverse uncolored. Stromata cylindrical, unbranched, up to 3 cm long x 2 mm diam, pale pink when young and remaining pink internally, exterior turning yellow, then black from base upward, becoming villose with olive-gray hyphae in 2-3 wk. Anamorph rare, produced in drying cultures on upper surfaces of some stromata. Conidiophores upright in palisades, branched near base, white in mass. Conidiogenous cells terminal, cylindrical, 15-25 x 4-5 μm, covered with denticulate conidial secession scars. Conidia produced holoblastically in sympodial sequence, hyaline, smooth,

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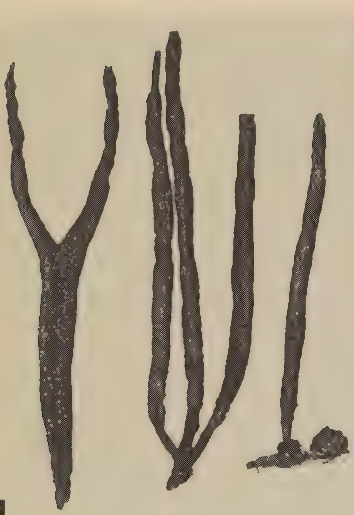
Figs. 1-7. *Xylaria adscendens* (AR 3119). 1. Stromata, X 1.0. 2. Ascus tip stained with Melzer's reagent and ascospores, X 2250. 3. Ascospores. Germ slit visible on left spore, X 1500. 4. Culture, X 1.3. 5. Conidiogenous cells, with apical secession scars visible, X 1375. 6. Conidiogenous palisade, X 1500. 7. Conidia, X 1500. Figs. 2, 5, 6 and 7 by DIC. Fig. 3 by BF.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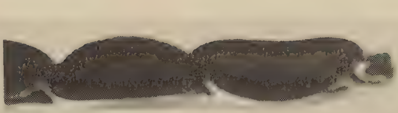
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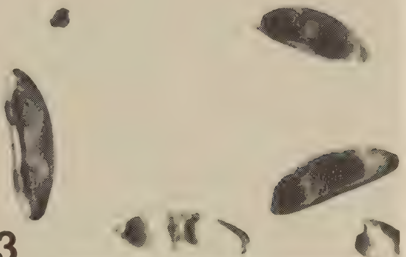
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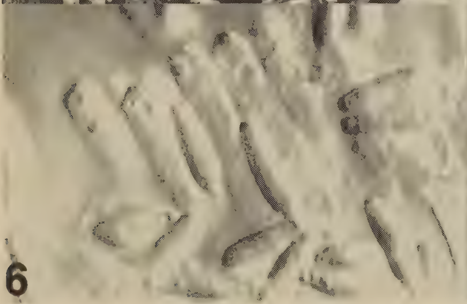
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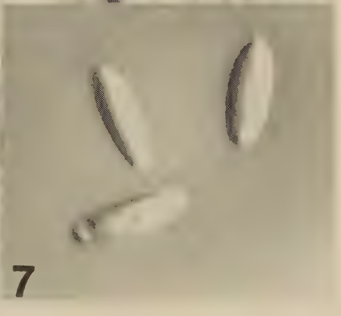
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elongated ellipsoid with small flattened bases indicating former points of attachment to conidiogenous cells, 10-12 x 2-3 μm.

SPECIMEN EXAMINED AND CULTURED: FRENCH GUIANA: A. Y. Rossman 3119 (JDR).

NOTE: This collection is typical of *Xylaria adscendens* as described by Dennis (1961), Rogers (1984a), and San Martín Gonzales & Rogers (1989). As the above authors have noted, it is closely related to *Xylaria hypoxylon* (L.:Fr.) Grev.; in fact, Dennis (1957) considered it to be a tropical variant of this species. As Rogers (1984a) suspected, cultural features help separate these species from each other and from *Xylaria mali* Fromme. *Xylaria adscendens* differs in its production of yellow pigment in culture and in having slightly larger conidia in nature and in culture than the other two species. *Xylaria hypoxylon* cultures are never brightly pigmented and produce conidia in nature averaging 7-10.7 x 2-3 μm (Rogers & Samuels, 1986, and unpublished data). According to Fromme (1928), *X. mali* is a temperate pathogen of apple, and in culture produces black, villose stromata with white to pink apices. Rogers (1984a) also noted that *X. adscendens* has never been reported as a pathogen of apple.

Xylaria cf. *allantoidea* (Berk.) Fr., Nova Acta Regiae Soc. Sci. Upsal. (ser. 3) 1, p. 127. 1851. Figs. 8-16.

Stromata clavate to cigar-shaped (fusoid) with rounded fertile apices, on slender stipes. Fertile portions 3.5-7.5 cm high x 0.8-1.5 cm diam, inrolled and hollow except for a layer of brown tissue ca. 1 mm deep below perithecia. Stipes cylindrical to strap-like, 2-4.5 cm long x 2-3 mm diam. Exterior black, smooth except for inrolling and large wrinkles. Perithecia globose, ca. 0.5 mm diam. Ostioles finely papillate. Asci 8-spored, cylindrical, long-stipitate, spore-bearing portions 75-100 x 5.5-8 μm, stipes 85-100 x 2-3 μm, with apical rings bluing in Melzer's iodine reagent, urn-shaped, 3.5-5 x 2.5-4 μm. Ascospores blackish-brown, narrowly ellipsoid-inequilateral, smooth, 12-13.5(-14) x 4-4.5(-5) μm, with straight, full-length germ slit.

Colonies slow-growing, reaching ca. 3-4 cm diam in 4 wk, at first white with submerged margins, and faint, irregular, concentric zones, darkening to yellowish tan and finally dark gray. Reverse colored dark brown towards center. Stromata more or less cylindrical, tapering towards apices, unbranched except at point of contact with Petri dish lid, up to 4 cm long x 1-2 mm diam, developing at centers of colonies and peripheries of zones. Stromata at first yellowish-tan (manila-colored), paling to off-white in areas of conidial production. Conidium-bearing regions on upper surfaces of stromata. Conidiophores upright in palisades,

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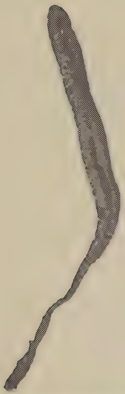
Figs. 8-16. *Xylaria* cf. *allantoidea* (AR 3221). 8. Stroma, X 0.4. 9. Stromatal tip showing inrolling; perithecia exposed at left, X 1.5. 10. Ascospores, one with germ slit evident, X 1400. 11. Asci with tips stained in Melzer's reagent, X 500. 12. Culture, X 1.5. 13. Conidiogenous cells with lateral and apical secession scars evident, X 1200. 14. Conidiogenous palisade with secession scars evident on individual cells, X 1200. 15. Conidia, with apical corona evident on left spore, X 2750. 16. Conidia, with apical corona evident on upper spore, X 4000. Figs. 11, 13, 15 by DIC. Fig. 10 by BF. Figs. 14, 16 by scanning electron microscopy.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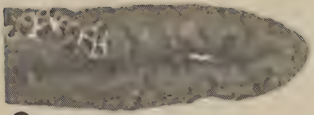
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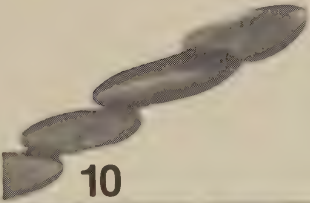
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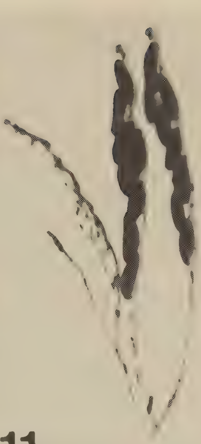
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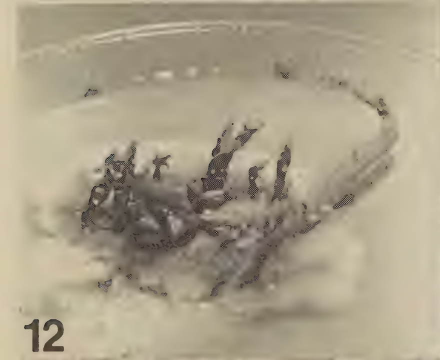
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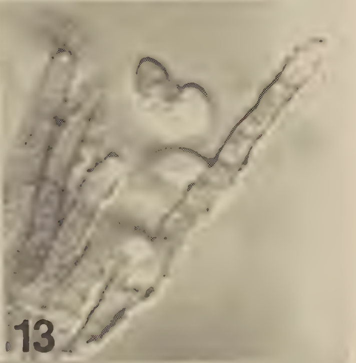
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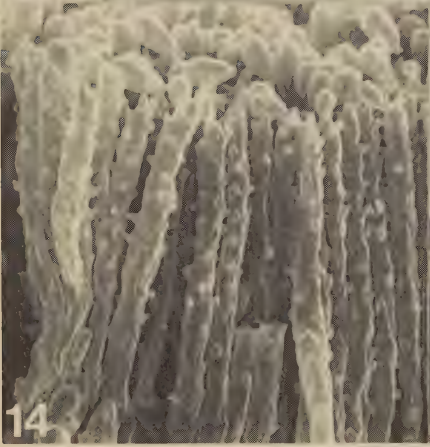
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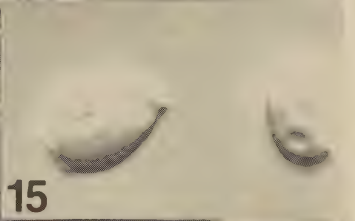
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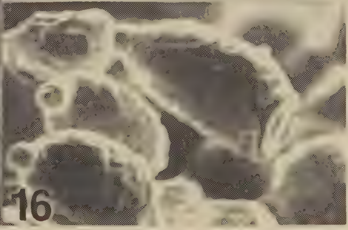
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branched near base, brown in mass, sloughing off in small, dusty clumps to reveal the dark gray stromatal surface underneath. Conidiogenous cells terminal, cylindrical, 35-50 x 3-4 μm, densely covered with small, jagged to denticulate conidial secession scars. Conidia produced holoblastically in sympodial sequence. Conidia hyaline (pale buff in mass), smooth, ovoid to obovoid, with small flattened bases indicating former points of attachment to conidiogenous cell, 7-11 x 4-4.5 μm. Some conidia with flattened apices or small, corona-like apical processes. Conidia germinating in culture.

SPECIMEN EXAMINED AND CULTURED: FRENCH GUIANA: A. Y. Rossman 3221 (JDR).

NOTES: This collection is very close to Rogers' (1984b) concept of *Xylaria allantoidea* (Berk.) Fr., having ascospores approximately the same size (Rogers cites 10-12 x 3.5-4.5 μm), with easily discernable straight germ slits slightly shorter than spore length. The collection differs from typical *X. allantoidea* in that the stromata, especially the stipes, are uncharacteristically long and slender. It bears some superficial resemblance to *Xylaria nigrescens* (Sacc.) Lloyd, especially in the hollow inrolled fertile portions of the stromata, but these two species are separable on ascospore size and morphology (San Martín Gonzales & Rogers, 1989).

In culture, our collection of *X. allantoidea* does not produce truly flabelliform coremia as does *X. cubensis*. As Rogers (1984b) has discussed, the anamorph of *X. allantoidea* was considered by Petch (1924) to be flabelliform, but Petch's corresponding description of the teleomorph indicates that he was dealing with *X. cubensis*. Our culture of *Xylaria allantoidea* produces conidia abundantly, but on cylindrical stromata that branch infrequently and usually only when in contact with the Petri dish lid. In addition, the colonies are slow-growing, unlike *X. cubensis* which exhibits rapid and unrestricted growth (Rogers, 1984b). Our culture of *X. allantoidea* is similar to *Xylaria poitei* (Lév.) Fr. in its restricted growth and prolific production of conidia, most of which have a distinctive apical structure (Rogers & Callan, 1986b). Conidia of the former do not usually develop such a prominent corona as in *X. poitei*, but many are apically flattened when viewed by light microscopy. These two species, however, appear to be closely related.

It is noteworthy that the culture and anamorph described here are very much like some cultures isolated by our colleague Y.-M. Ju from *X. allantoidea* teleomorphs collected in Asia. On the other hand, we have examined some other cultures, isolated from *X. allantoidea* teleomorphs collected in South America, that cover plates in 10-14 da and produce stromata in 30 da. In growth rate and color these cultures resemble those of *X. cubensis* (Rogers, 1984b; see notes on *X. sp.* aff. *cubensis* herein). However, flabellate stromata are not formed and conidia are rarely formed. The conidia that are formed do so only after ca. 2 months and are 5-7 x 2.5-3.5 μm.

Rogers (1984b) hypothesized that *X. allantoidea*, like *X. cubensis*, produces conidia on coremia that do not produce perithecia. Indeed, to our knowledge, collections to date have not revealed teleomorphic stromata covered with remnants of the anamorph. Stromata are consistently smooth and devoid of conidiogenous remnants. Additional field observations of developing stromata are needed to determine if the anamorphs and teleomorphs of these fungi are produced on independent structures. See Notes on *Xylaria* sp. aff. *cubensis* herein.

Xylaria arbuscula Sacc., Michelia 1:249. 1878. Figs. 64 and 65.

For description of teleomorph see Rogers et al (1988).

Colonies covering Petri dish in 2-3 wk, at first whitish, velvety to felty or floccose, often strongly zonate, becoming overlain with a brownish to blackish gray layer of coarse felty mycelium, the surface of which later becomes flocculose and lighter in patches. Reverse uncolored to light brown. Stromata usually forming in regular, more or less concentric zones, cylindrical, ca. 1-3 cm tall x 1-3 mm diam, blackish gray and felty except for white, velvety conidiogenous regions and growing tips, with tan to white fleshy interiors. Conidiophores formed in powdery palisades on upper surfaces of stromata or in loose tufts ca. 1 mm tall x 1 mm diam, on surface of colony. No apparent morphological difference between conidiogenous structures from either location. Conidiophores frequently branched near base, white in mass. Conidiogenous cells terminal, cylindrical, 5-15 x 3-4 μm, bearing denticular, usually apical conidial secession scars. Conidia produced holoblastically in sympodial sequence. Conidia hyaline, smooth, narrowly ellipsoid, occasionally with slightly pointed apices, with small, flattened bases indicating former points of attachment to conidiogenous cells, (3-)4.5-5.0(-6) x 2.0-2.5(-3) μm. Conidia apparently not germinating in culture.

SPECIMENS EXAMINED AND CULTURED: BRAZIL: Estado de Amazonas, 0.3 km S of central portion of Serra Araca and 0.8 km E of Rio Jauari, elev. 60 m, 00°49'N, 63°19'W, G. J. Samuels 748, 13.III.1984 (NY; JDR). CANARY ISLANDS: Tenerife, on wood, Baudet 2392, 2.II.1985 (JDR).

NOTES: Our cultures of *X. arbuscula* are similar to those described by Martin (1970) especially those isolates producing strongly delimited zones and black stromata with white apices. Rogers and Samuels (1986) cultured New Zealand specimens and found them to be astromatic with yellow-tan to orange-tan mycelium. Rick (1935) mentioned slender, tomentose, conidium-bearing stromata with white to rose apices in nature. He did not describe the conidia. Our colonies were entirely black and white, with no additional colors apparent. The specimen from the Canary Islands tended to produce fewer and more robust stromata than South American collections, but shared the same anamorphic features and dimensions.

Xylaria atrosphaerica (Cooke & Massee) Callan & J. D. Rogers, comb. nov. Figs. 17-24.

Basionym: *Hypoxylon atrosphaericum* Cooke & Massee, Grevillea 22:68. 1894.

Kretzschmaria atrosphaerica (Cooke & Massee) P. Martin, J. S. African Botany 36:79. 1970.

Penzigia atrosphaerica (Cooke & Massee) J. H. Miller, Mycol. Explor. Venezuela, Mongr. Univ. Puerto Rico, ser. B, 2, p. 212. 1934.

Stromata scattered over surface of bark, pulvinate, irregular in outline, faintly moriform, with a narrow central connective; fertile portion 1.5-4 mm diam x 1-2 mm high; connective more or less cylindrical, 1 mm x 1 mm, slightly wider at apex. Exterior brownish-black, roughened by fine cracks and ostioles; interior whitish to pale tan, corky. Perithecia globose, 0.5-1.0 mm diam. Ostioles inconspicuous, faintly papillate. Asci 8-spored, cylindrical, stipitate, spore-bearing portions 105-120 x 7-9 μm, stipes 60-90 x 3-4 μm, with apical rings bluing in Melzer's iodine reagent, cylindrical, 5-6 μm tall x 4-4.5 μm broad. Ascospores brownish-black, ellipsoid-inequilateral, smooth, (17-)18-20(-21) x 6-7 μm, with germ slit diagonal, ca. 3/4 spore-length.

Colonies covering Petri dish in 2 wk, at first white, velvety, with floccose margins, zonate, with radiating ridges, darkening to charcoal gray from center outwards. Dark layer overlain with a thin, felty layer of white, often tightly coiled mycelium which becomes canary yellow. Reverse grayish pink, soon deepening to gray. Stromata abundant, cylindrical, 2-4 cm tall x 1-2 mm diam, unbranched or branched once to several times at point of contact with lid of Petri dish, initially white, soon darkening to charcoal gray, then covered with parallel strands of yellow hyphae. Interior white, fleshy. Conidiogenous regions on upper stromatal surfaces. Conidiophores upright in palisades, unbranched to sparingly branched near base, white in mass, eventually sloughing off in flakes to reveal the darkened stromatal surface below. Conidiogenous cells terminal, cylindrical, 40-60 x 3-5 μm, bearing lateral and apical denticulate conidial secession scars. Conidia produced holoblastically in sympodial sequence. Conidia hyaline, smooth, obovoid to obclavate, with flattened bases indicating former points of attachment to conidiogenous cell, (7-)7.5-9 x 3-3.5 μm. Conidia germinating in culture.

SPECIMEN EXAMINED AND CULTURED: FRENCH GUIANA: G. J. Samuels 4494 (NY; JDR).

NOTES: The teleomorph of this collection corresponds closely with the description of this species (as *Penzigia atrosphaerica*) by Rogers et al (1987). The generic concept of *Penzigia* is ill-defined (Rawla & Narula, 1983; Miller, 1961; Dennis, 1961; Rogers, 1981), and we suspect that most (if not all) of its species may eventually be accommodated in either *Xylaria* or *Hypoxylon*, based primarily on the nature of cultures produced by these fungi. Apart from its reduced pulvinate stroma, there are no other features of *X. atrosphaerica* that differ significantly from typical members of the genus. In culture (Fig. 20), stromata have an upright, cylindrical habit and bear palisades of conidiophores, as is typical of most *Xylaria* species. If this fungus were to be considered an *Hypoxylon* species, the anamorph would most likely be in the form of individual conidiophores scattered over the surface of the colony independent of developing teleomorphic stromata. The differences among stromata collected from nature and those produced in culture is great and invites speculation as to the nature of the environmental factors that dictate the development of one form instead of the other. However, other species of *Xylaria* also produce a range of morphologies, some of which are penzigioid, e.g. *Xylaria anisopleura* and *X. scruposa* (Rogers & Callan, 1986a).

Figs. 17-24. *Xylaria atrosphaerica* (GS 4494). 17. Penzigioid stromata, X 3.5. 18. Ascus tip stained in Melzer's reagent (arrow), X 1800. 19. Ascospores, one showing sigmoid germ slit, X 1000. 20. Culture, X 0.9. 21. Conidiogenous cell covered with secession scars, X 2100. 22. Conidiogenous cells branching from conidiophore. Note apical secession scars, X 2100. 23. Conidia, X 875. 24. Germinating conidium, X 810. Figs. 21-24 by DIC. Figs. 18 and 19 by BF.

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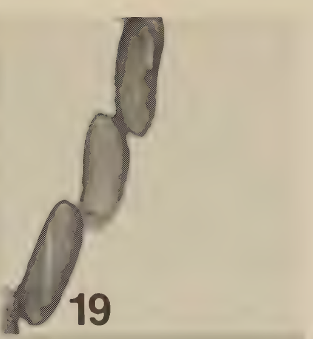

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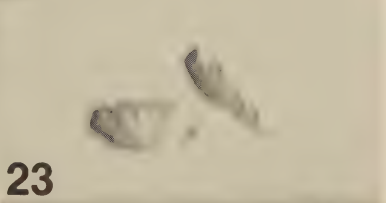

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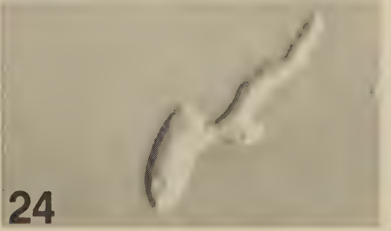

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Regardless of their stromatal configuration, cultures derived from these different forms were very similar. Therefore, it is possible that *X. atrosphaerica* exists in nature in other, more typically xylarioid forms as well.

The strikingly pigmented colonies of *X. atrosphaerica* are reminiscent of *X. coccophora* Mont. (Rogers et al, 1988).

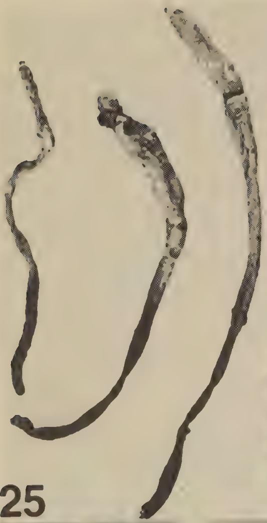
Xylaria enteroleuca (Speg.) P. Martin, J. S. African Bot. 36:100. 1970.
Figs. 33-42.

Stromata peltate to flattened conic, with perithecial ostioles on upper, flattened surfaces only, 5-15 mm diam x 2-3 mm deep; stipes narrow, central, up to 5 mm long x 2-3 mm diam, mostly reduced to a short, narrow connective. Exterior of young stromata silvery-tan, splitting in long fissures to expose blackened layer below. Interior white, corky. Perithecia globose, 0.5-0.75 mm diam. Ostioles indistinct to hemispherical. Asci 8-spored, cylindrical, long-stipitate, spore-bearing portions 90-95 x 7-8 μm, stipes 80-110 x 4-5 μm, with apical rings bluing in Melzer's iodine reagent, rectangular to cuneiform, 1 μm tall x 2 μm broad. Ascospores brownish-black, broadly ellipsoid-inequilateral with a tiny cellular appendage on one end of immature spores, smooth, 11-13 x 6-7(-8) μm, with germ slit straight, full-length, indistinct.

Colonies covering Petri dish in ca. 2 wk, at first white, cottony, zonate, darkening to gray in scattered patches. Reverse uncolored. Stromata developing over surface of colony in irregular zones, most numerous at periphery, highly variable in shape, those toward center tending to be slender, more or less cylindrical, 1-2 cm high x 1-2 mm diam, fragile, branching once to many times along main axis, especially where contact is made with Petri dish lid, those towards periphery of cultures often pulvinate, up to 0.5 cm high x 1 cm diam, or strongly flabelliform, up to 1 cm high x 1 cm broad. Stromata at first white to pale rose, becoming covered from the base upward with dense, brownish gray villose hyphae. Conidium-bearing regions on upper surfaces of stromata. Conidiophores upright in palisades, branched near base, pale olive-gray in mass, sloughing off in flakes as stromata mature. Conidiogenous cells terminal, cylindrical to faintly geniculated, 40-50 x 2.5-3 μm, pale brown in mass, smooth-walled, bearing minutely discoid to punctate conidial secession scars. Conidia produced holoblastically in sympodial sequence. Conidia hyaline (pale olive-brown in mass) smooth, oblong to obovate, with flattened bases indicating former points of attachment to conidiogenous cell, 4.5-7 x 2-3 μm.

SPECIMEN EXAMINED AND CULTURED: USA: Hawaii, on dying moss-covered *Macadamia* trunk, W. H. Ko, 1.VIII.1988 (JDR).

Figs. 25-32. 25 and 26. *Xylaria* cf *curta* (AR 3226). 25. Stromata, X 0.4. 26. Culture, X 0.75. 27-29. *Xylaria curta* (Samuels & Rodrigues). 27. Culture, X 1.8. 28. Conidiogenous cells with secession scars visible, X 1500. 29. Conidia, X 1170. 30-32. *Xylaria feejeensis*. 30. Culture, X 1.3. 31. Conidiogenous cell with geniculations and secession scars visible, X 750. 32. Conidia, X 1500. Figs. 28 and 29, 31 and 32 by DIC.



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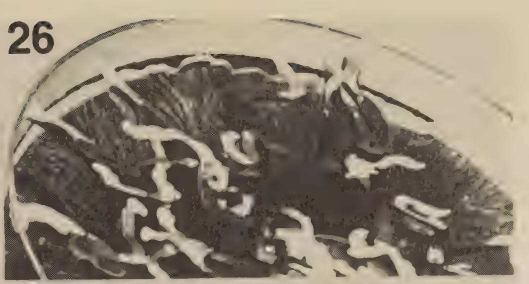

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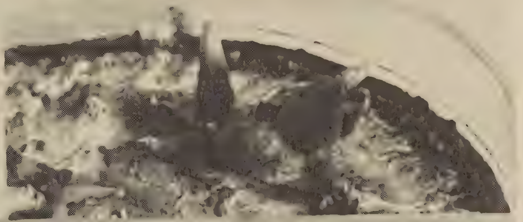

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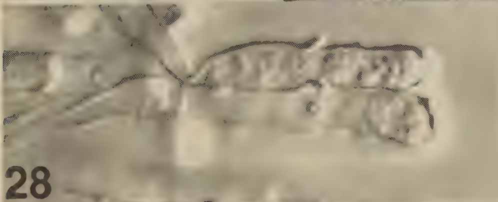

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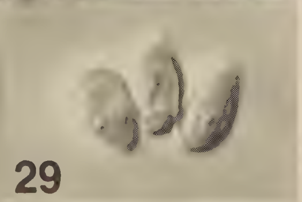

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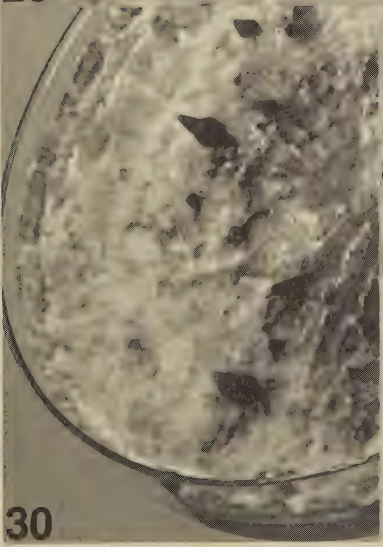

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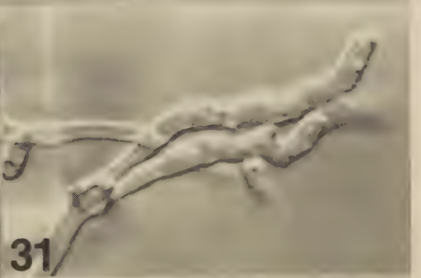

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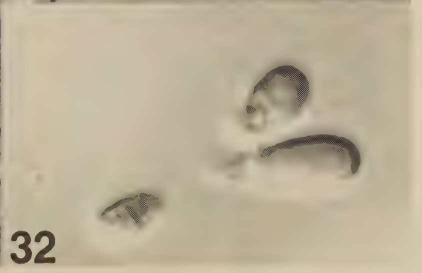

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NOTES: This is another penzigioid species [≡ *Penzigia enteroleuca* (Speg.) J. H. Miller] that is proven by culture to be a *Xylaria*. *Xylaria enteroleuca* is difficult to separate from *X. berteri* (Mont.) Cooke [≡ *Penzigia berteri* (Mont.) J. H. Miller] and might ultimately prove to be conspecific with it. The present material best fits Miller's concept of *X. enteroleuca* (as *Penzigia*) "in the absence of the coarse scales and in being cupulate-depressed rather than convex" (Chardon et al, 1940). Martin (1970) cultured both *X. berteri* and *X. enteroleuca*. His description of *X. berteri* cultures seem similar to ours in producing stromata that were highly variable in size, were pink and gray in color, and that bore gray masses of conidia 3.7-7.6 x 1.4-2.3 μm (Martin, 1970). Following his description of *X. enteroleuca* cultures he remarked: "This species is similar to *X. berteri*, differing in minor stromal characters and in the slower growth rate in culture." In any case, we suspect that this fungus is allied to *X. cubensis* (Mont.) Fr. in producing separate and distinct anamorphic and teleomorphic structures in nature (see Rogers, 1984b).

Xylaria curta Fr., Nova Acta Regiae Soc. Sci. Upsal. (ser. 3) 1, p. 126. 1851.
Temperate Collection Figs. 27-29.

A general description of the teleomorph can be found in Rogers (1983).

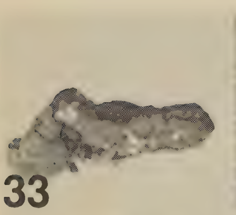
Colonies reaching edge of Petri dish in ca. 2 wk, at first white, velvety, appressed, then floccose, pale pink to tan, overlain with irregular patches of blackish hyphae. Reverse faintly pink. Stromata cylindrical with acute apices, broadening at base with age, 1-3 cm long x 0.5-1.0 cm diam, at first pale pinkish tan, then dark olive gray as conidiogenous layer develops. Conidia produced over entire surface of stromata, sloughing off in flakes from base upwards as stromata elongate, replaced with a dense, blackish-olive villose covering of hyphae ca. 1-2 mm long. Conidiophores upright in palisades, branched near base, olive-gray in mass. Conidiogenous cells terminal, cylindrical, 45-55 x 4(-5) μm, covered with discoid to crateriform conidial secession scars. Conidia produced holoblastically in sympodial sequence. Conidia hyaline, smooth, lacrymoid to obovate with small flattened bases indicating former points of attachment to conidiogenous cell, (5-)6-7(-7.5 x 3-4 μm. Conidia rarely germinating in culture.

SPECIMEN EXAMINED AND CULTURED: USA: New York, Hamilton Co., Racquette Lake, on *Fagus sylvatica*, G. J. Samuels & K. F. Rodrigues, 6.IX.1986 (NY; JDR).

Xylaria cf. *curta* Fr. Tropical collection. Figs. 25 and 26.

Stromata cylindrical, stipitate, occasionally branched with two fertile portions from common stipe, fertile portions 4.5-5.5 cm x 3-5 mm, stipes 1.5-2.5

Figs. 33-42. *Xylaria enteroleuca*. 33. Stroma viewed from side, X 2.5. 34. Stromatal surface with hemispherical perithecial ostioles, x 12. 35. Ascus apical part showing one ascospore and tip stained with Melzer's reagent, X 2300. 36. Stroma viewed from above, X 2.5. 37. Ascospore with germ slit visible, X 1700. 38. Germinating ascospore, X 460. 39. Culture, X 0.7. 40. Conidiogenous palisade, X 1600. 41. Conidiogenous cells with conidial secession scars evident, X 2000. 42. Conidia, X 2000. Figs. 38, 40-42 by DIC. Fig. 35 by BF.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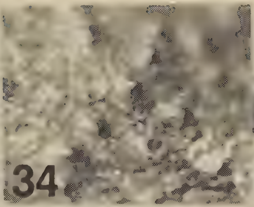
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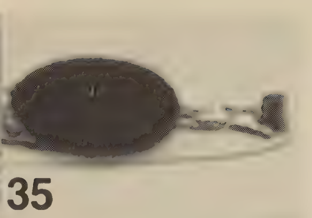
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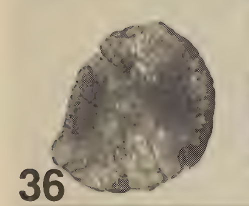
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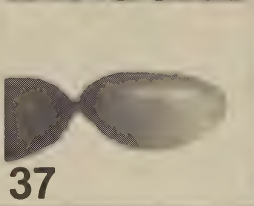
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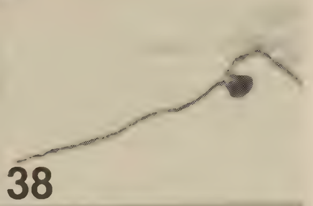
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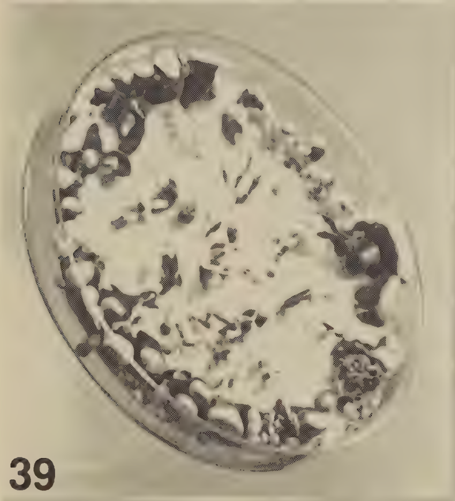
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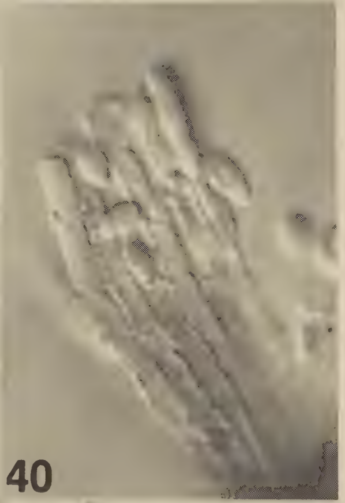
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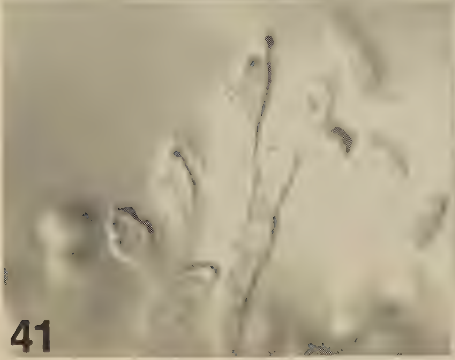
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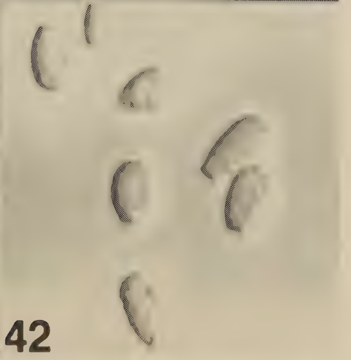
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cm x 2.5-4 mm. Exterior light brown, highly wrinkled, cracked around perithecial ostioles to expose black underlying layer. Interior white, corky. Stipes externally brownish-black, slightly felty towards base. Perithecia globose, ca. 0.5-0.75 mm diam. Ostioles discoid to hemispherical, pale brown. Asci 8-spored, cylindrical, long-stipitate, spore-bearing portions 60-75 x 5-6 μm, stipes 75-115 x 4-4.5 μm, with apical ring bluing in Melzer's iodine reagent, urn-shaped, 4 μm high x 2 μm broad. Ascospores blackish-brown, ellipsoid-inequilateral, smooth, (8-)8.5-9.5 x 4-4.5 μm, with straight, full-length germ slit and small cellular appendage on one end when immature.

Colonies covering Petri dish in 3 wk, at first white, velvety, appressed, azonate, with narrowly plumose margins, soon darkening from center outwards to dull black and becoming overlain in places by feathery tufts of white hyphae. Reverse tan. Stromata scattered over surface of colony but most common at periphery, cylindrical, 1-2.5 cm long x 1-3 mm diam, unbranched, or occasionally branched at point of contact with Petri dish lid, at first white to pale tan, darkening from base upwards with a blackened layer which eventually becomes villose. No conidiogenous structures observed.

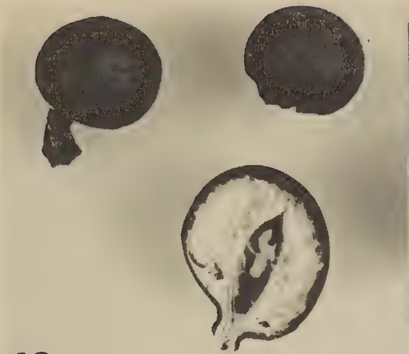
SPECIMEN EXAMINED AND CULTURED: FRENCH GUIANA: A.Y. Rossman 3226 (JDR).

NOTES: Rogers (1983) has discussed *Xylaria curta* in detail and our temperate collection agrees with his description. Our culture is described herein in order to supplement Rogers' observations (1983), which were from colonies on potato dextrose agar amended with yeast extract. Generally, cultures are more robust on oatmeal agar, but conidial measurements are similar. Both descriptions agree with those of Martin (1970).

As Rogers (1983) noted, the type of this species is based on an Hawaiian specimen, and Dennis (1956) described the stromata, especially immature specimens, as being covered with white or cream-colored scales. The teleomorph of this tropical collection remains tan at maturity and is longer overall and with more elongated slender stipes than most temperate material. Moreover, ascus tips are also larger, up to 4 μm high compared to 2 μm, but ascospores are identical with those of temperate collections. Cultures of the tropical collection have some similarities such as villose stromata, but differ in their distinctive plumose margins. The differences depicted above indicate that there is variation among collections of *Xylaria curta*. Unfortunately, an anamorph was not produced in our culture.

Xylaria enterogena (Mont.) Fr., Nova Acta Regiae Soc. Sci. Upsal. (ser. 3) 1, p. 127. 1851. Fig. 72.

Figs. 43-49. *Xylaria obovata* (Lodge 186). 43. Stromata, one on lower right in longitudinal section, X 1.2. 44. Ascus tip in Melzer's reagent, X 2000. 45. Ascospores with germ slits evident, X 1300. 46. Culture, X 1.1. 47. Conidiogenous cells, X 1000. 48. Palisade of conidiogenous cells, some with apical secession scars, X 1380. 49. Conidia, X 1200. Figs. 47-49 by DIC. Figs. 44 and 45 by BF.



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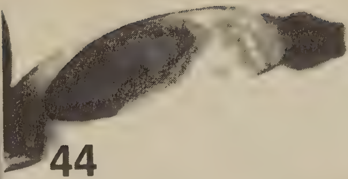

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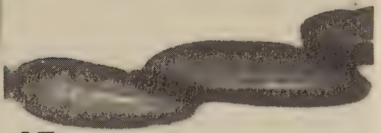

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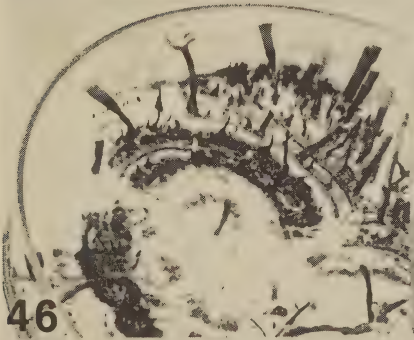

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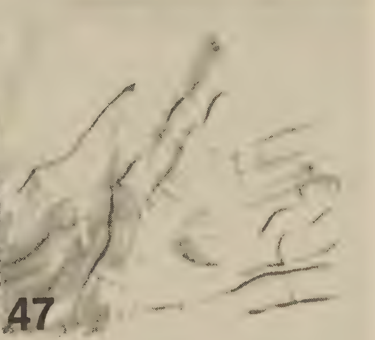

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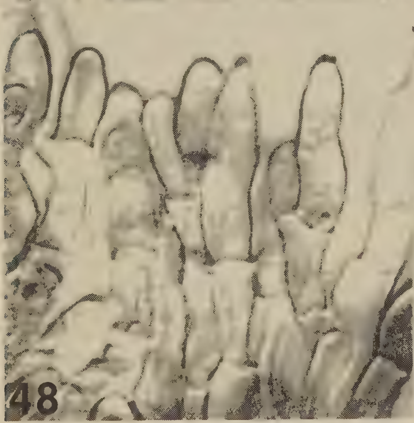

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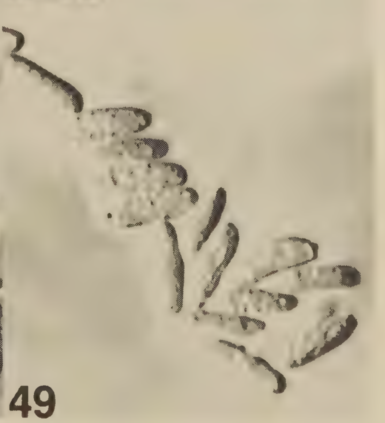

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Stromata cylindrical, clavate, short-stipitate, fertile portions 1-2 cm x 4-6 mm, stipes cylindrical to strap-like, 2-4 mm tall x 2 mm broad, smooth. Exterior pale yellowish cream overlying a blackened layer. Interior tan, darkening and degenerating in fertile portion which becomes hollow when mature. Perithecia globose, ca. 0.5 mm diam. Ostioles punctate, inconspicuous. Asci 8-spored, cylindrical, short-stipitate, spore-bearing parts 105-140 x (7-)9-11 μm, stipes 50-65 x 3-3.5 μm, with apical ring bluing in Melzer's iodine reagent, cylindrical to urn-shaped, 7 μm high x 4 μm broad. Ascospores brownish black, unicellular, ellipsoid-inequilateral, with ends slightly pinched, smooth, 17-20(-20.5) x 6-7 μm with germ slit diagonal, ca. 2/3 spore-length.

Colonies reaching edge of Petri dish in 2 wk, at first white, velvety, appressed, strongly zonate, with floccose, lobed margins, darkening at center to olive gray and covered with tightly coiled hyphae. Reverse uncolored. Stromata developing from mycelial strands or fans at periphery of zones which turn upward and elongate perpendicular to the colony surface, cylindrical, 0.2-0.5 cm tall x 0.5-1 mm diam, white, darkening at base which becomes covered by a thin layer of coiled, olive-gray hyphae. No conidiogenous structures observed.

SPECIMENS EXAMINED AND CULTURED: FRENCH GUIANA: A. Y. Rossman 3157, 3275 (JDR).

NOTES: *Xylaria enterogena* has been separated from *X. telfairii* on the more yellow color and the smaller size of the stromata and smaller ascospores of the former (Rogers et al, 1988), and the fact that ascospore germ slits of *X. enterogena* tend to spiral while those of *X. telfairii* are straight (Martin, 1970, San Martín Gonzales & Rogers, 1989). Our specimens exhibit these differences, but cultures from collections of both species are virtually identical. If, indeed, these fungi are separate species, it is not possible to separate them using features of the cultures described herein.

Xylaria feejeensis (Berk.) Fr. Nova Acta Regiae Soc. Sci. Upsal. (ser. 3) 1, p. 128. 1851. Figs. 30-32.

Stromata cylindrical to spathulate, 3-4 cm total height x 0.5 cm - 1 cm diam, fertile portions 1.5-3 cm tall x 0.7-1 cm diam, stalks 1-2 cm tall x 3-0.5 mm diam. Exterior black, wrinkled, roughened with perithecial ostioles and cracked into small plates. Interior white, corky. Perithecia 0.3-0.5 mm diam. Ostioles hemispherical, prominent. Asci 8-spored, cylindrical, long-stipitate, spore-bearing portions 55-65 x 4-6 μm, stipes 85-100 x 2.5-3 μm, with apical ring bluing in

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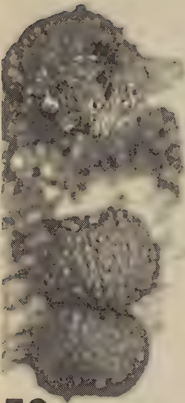
Figs. 50-58. *Penzigia* cf. *indica*. 50. Stromata (GS 4420), X 4. 51. Ascus tip in Melzer's reagent (GS 4418), X 1330. 52. Ascospores, spore on left with germ slit evident (GS 4418), X 760. 53. Ascus tip of isotype material (Narula 16235) remaining unstained in Melzer's reagent, X 1700. 54. Ascospore (GS 4418) with hyaline apical appendage evident, X 2000. 55. Culture (GS 4418); perithecial initials evident on central stroma, X 2.5. 56. Young conidiogenous cells with apical secession scars (GS 4418), X 2000. 57. Palisade of mature conidiogenous cells; lateral scars evident (GS 4418), X 1250. 58. Conidia (GS 4418), X 1250. Figs. 51, 53, 54-58 by DIC. Fig. 52 by BF.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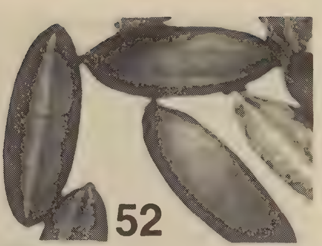
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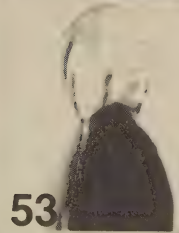
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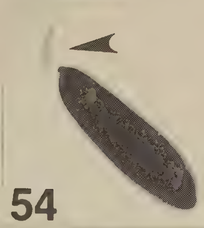
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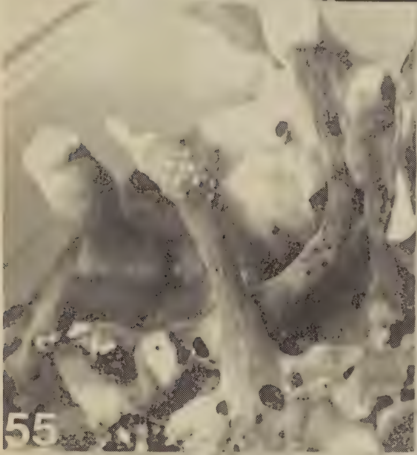
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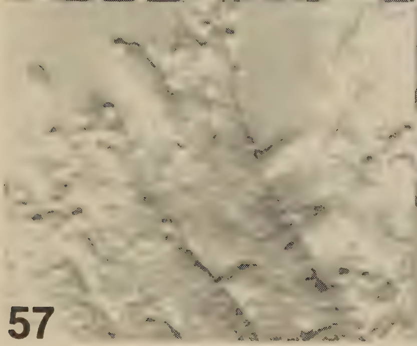
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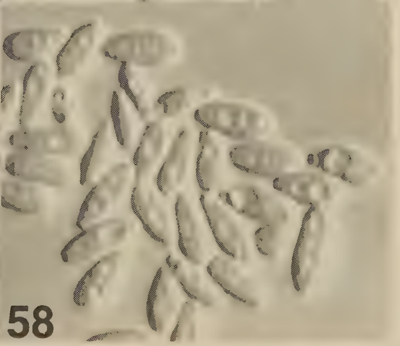
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Melzer's iodine reagent, quadrate, 1.5-2 x 2 μm. Ascospores brownish-black, unicellular, broadly ellipsoid-inequilateral, smooth, 8-9 x 4-4.5 μm, with straight, somewhat faint, full-length germ slit.

Colonies covering Petri dish in 3 wk, at first white, velvety, appressed, with uneven, more or less concentric zones, becoming floccose at edge of Petri dish, turning tan, then blackening towards center and becoming overlain with white floccose hyphae. Most colonies eventually furrowed with radiating depressions at maturity. Reverse uncolored. Stromata developing at periphery and on radiating edges of colonies, cylindrical, 0.5-1 cm tall x 3-4 mm diam, pulvinate when young, later covered from base upward with velvety, villose black hyphae. Conidium-bearing regions developing on surface of colony in small tufts independent of stromata and on young, pulvinate stromata prior to the production of villose basal hyphae. Conidiophores in dense, whitish to pale tan palisades, sloughing off in flakes as stromata age, unbranched to branched several times from base. Conidiogenous cells terminal, cylindrical, 15-30 x 4-5 μm, with lateral and terminal crateriform scars indicating former sites of conidial attachment. Conidia produced holoblastically in sympodial sequence. Conidia hyaline, smooth, obovoid to ellipsoid, with flattened bases indicating former points of attachment to conidiogenous cell, 5-6 x (2-)3 μm. No germinated conidia observed.

SPECIMEN EXAMINED AND CULTURED: PUERTO RICO: Luquillo Mts., El Verde, on wood, D. J. Lodge 424, 1988 (JDR).

NOTES: This collection of *X. feejeensis* fits Dennis' (1956) description well. Rogers et al (1987) noted that this species is allied to *X. curta*, and similarities in the cultures of these two fungi are evident, especially with respect to the villose dark stromata. Cultures of *Xylaria feejeensis* more closely resemble temperate than tropical *X. curta* cultures.

Xylaria microceras (Mont.) Fr., Nova Acta Regiae Soc. Upsal. (ser. 3) 1, p. 128. 1851. Tropical Collection. Fig. 63.

Stromata cylindrical with slender stipes and acute apices, simple or with a few branches. Fertile portions 1-2 cm tall x 1-3 mm diam (larger diam = branched stromata), stipes 3-5 mm tall x 0.5-1 mm diam. Exterior with tan external layer peeling away in longitudinal strips to reveal blackened layer beneath. Interior tissue white, fragile. Perithecia globose, ca. 0.25-0.5 mm diam. Ostioles punctuate. Asci 8-spored, cylindrical, stipitate, spore-bearing portions 80-90 x 4-4.5 μm, stipes 90-120 x 2 μm, with apical ring bluing in Melzer's iodine reagent, inverted hat-shaped, 2-3 μm high x 2 μm broad. Ascospores blackish-brown, unicellular, ellipsoid-inequilateral, smooth, 10-11 x 3-4 μm, with a minute, cellular appendage on either end, and a straight, nearly full-length germ slit.

Colonies covering Petri dish in 3 wk, at first white, velvety, appressed, with several irregularly-scalloped concentric zones, darkening to gray at center, which in turn is covered with whitish plumose hyphal strands radiating outward toward edge of colonies. Surface dry, rugulose towards periphery. Reverse at first uncolored, darkening to gray as colony ages. Stromata developing at center of colonies, cylindrical to flabellate, ca. 1 cm tall x 0.5-4 mm diam, unbranched to branched several times from base, often densely cespitose, initially white to pale tan, darkening to charcoal from base upwards except for growing tips. Conidium-bearing regions arising in small, pulvinate clumps on surface of colony apart from stromata, and on upper surfaces of stromata. Conidiophores upright in palisades, unbranched to sparingly branched near base, pale tan to gray in mass, eventually sloughing off in flakes. Conidiogenous cells terminal, cylindrical, 10-15 μm x 2-2.5 μm, bearing denticulate conidial secession scars. Conidia produced holoblastically in sympodial sequence. Conidia hyaline, smooth, obovoid to obclavate, guttulate, with flattened bases indicating former points of attachment to conidiogenous cell, 5-6(-6.5) x 2-2.5 μm. Conidia germinating in large numbers in culture.

SPECIMEN EXAMINED AND CULTURED: PUERTO RICO: Luquillo Mts., El Verde, on wood, D. J. Lodge 418, 3.VII.1988 (JDR).

Xylaria microceras. Temperate collection. Figs. 61 and 62.

Teleomorph as described earlier herein and by Dennis (1956).

Colonies covering Petri dish in 4 wk, with mycelium at first white, floccose, zonate towards center, darkening to pale yellowish-brown. Stromata narrowly cylindrical, unbranched, up to 5 mm tall x 1 mm diam, produced in concentric rings at periphery of zones, at first white then tan and dotted with amber exudation droplets, then covered except for growing tips with a thin, grayish-black layer. Conidium-bearing regions on upper surfaces of stromata, in sparse, tan to whitish palisades. Conidiophores upright, sparingly branched near base, white to tan in mass, smooth-walled. Conidiogenous cells terminal, cylindrical, 10-20 x 3-4 μm, bearing denticular conidial secession scars. Conidia hyaline, smooth, guttulate, narrowly obovoid to obclavate, with flattened bases indicating former points of attachment to conidiogenous cell, (4.5-)5-6 x 2-2.5 μm. Conidia germinating soon after formation in culture.

SPECIMEN EXAMINED AND CULTURED: USA: Illinois, Piatt Co., Allerton Park, on wood, S. Bissonnette, 22.IX.1988 (JDR).

NOTES: The above-cited *Xylaria microceras* collections all seem typical of the species as described by Dennis (1956). There were a few differences between the temperate and tropical cultures, however. The collection from Puerto Rico produced fewer, more robust stromata which were usually colored black and white. On the other hand, the collection from Illinois produced prolific numbers of stromata which were pigmented pale tan. Conidia were the same size, and germinated in culture soon after formation. These cultures differ significantly from those of the allied species, *Xylaria coccophora* Mont., which has larger conidia 8-9 x 3-4 μm, and cultures with yellow-pigmented hyphae (Rogers et al, 1988).

Xylaria obovata (Berk.) Fr., Nova Acta Regiae Soc. Sci. Upsal. (ser. 3) 1, p. 127. 1851. Figs. 43-49.

Stromata globose to subglobose, sessile to short-stipitate, fertile portions 0.5-5 cm tall x 0.5-1.3 cm diam, stipes when present cylindrical, 1-5 mm long x 2 mm diam. Exterior smooth, very hard, brownish to black when young and covered with a thin tan to brownish layer cracked into minute plates. Interior reddish tan, disintegrating at center in mature stromata. Perithecia globose, ca. 1 mm diam. Ostioles discoid, inconspicuous. Asci 8-spored, stipitate, cylindrical, spore-bearing portions 150-180 x 10-12 μm, stipes 80-100 x 2.5-4 μm, with apical ring bluing in Melzer's iodine reagent, urn-shaped to cylindrical, 4-5 μm high x 4-5 μm broad. Ascospores smooth, brownish-black, unicellular, ellipsoid-inequilateral, (24-)26-30(-31) x (6.5-)7-8 μm, with straight germ slit 1/2-2/3 spore-length.

Colonies covering Petri dish in 3-4 wk, at first hyaline, submerged, then whitish, zonate, floccose, surface becoming brownish black and overlain with scattered patches of thin, white, floccose mycelium. Reverse tan to reddish brown. Stromata developing in waves at peripheries of zones, cylindrical to clavate to spathulate, fragile, 1-2 cm tall x 1-5 mm diam, initially white, becoming covered with white conidiogenous palisades under which the tissue becomes brownish black. Conidiogenous layer sloughing off to expose darkened layer beneath. Conidiophores sparingly branched near base, in dense palisades. Conidiogenous cells terminal, cylindrical, 16-25(-28) x 3-4 μm, hyaline to faintly grayish brown, with apical, conical secession scars. Conidia produced holoblastically in sympodial succession. Conidia hyaline, smooth, oval to obclavate, 8-10 (-10.5) x 3-3.5 μm, with truncate bases indicating former points of attachment to conidiogenous cells. Conidia germinating in culture.

SPECIMENS EXAMINED AND CULTURED: PUERTO RICO: Luquillo Mts., El Verde, D. J. Lodge 186, 5.II.1986 (JDR).

NOTES: These collections of *Xylaria obovata* are similar to Dennis' (1956) description of this species. Stromata are typically smooth, with subglobose fertile portions which become hollow with age. Dennis (1956) considered *X. obovata* a tropical form of *Xylaria polymorpha*, and certainly the two species are very similar in ascospore size and morphology, but the former lacks the roughened warty stromatal exterior so typical of the *X. polymorpha* species complex (Rogers & Callan, 1986a). In addition, the colonial morphology differs from *X. polymorpha* and related species (Rogers & Callan, 1986a) in that conidiogenous palisades remain white in mass instead of darkening with age to olive-gray. Rick (1935) and Theissen (1909) both noted that immature, conidium-bearing stromata were silvery-gray. It would appear that *X. obovata* is not a member of the tropical *X. polymorpha* species complex.

Xylaria sp. aff. *cubensis* (Mont.) Fr., Nova Acta Regiae Soc. Sci. Upsal. (ser. 3) 1, p. 126. 1851. Figs. 59 and 60.

Stromata fusiform, stipitate, fertile portions 4.5 cm x 1.3 cm (widest at center), stipes 2.5 cm x 4 mm. Exterior smooth, dark brown over black with fine cracks and ostiolar papillae. Texture hard, brittle. Interior white, becoming hollow in center. Perithecia globose, ca. 0.3-0.5 mm diam. Ostioles finely papillate. Asci 8-spored, cylindrical, long-stipitate, spore-bearing portions 50-64 x 7-11 μm, stipes 90-115 x 2 μm, with apical ring bluing in Melzer's iodine reagent, urn-shaped, 2-3 μm high x 2 μm broad. Ascospores brownish-black, unicellular, ellipsoid-inequilateral, smooth, 9-10.5 x 4-5 μm, with germ slit faint, full-length.

Colonies covering Petri dish in 3 wk, at first white, velvety, appressed, faintly zonate, darkening from center outward with a thin, gray layer of pale tan to white floccose hyphae. Reverse uncolored. Stromata at first cylindrical with uppermost half soon broadening, sometimes branching to become flabelliform, 1-2 cm tall x 0.2-1 cm diam, developing at surface and periphery of colony, initially white, then darkening from base upward to charcoal, the flabelliform portion deepening to pinkish or grayish tan. Conidium-bearing regions covering entire surface of young stromata and upper flabelliform surfaces of older stromata.

Conidiophores upright in dense, dry palisades, unbranched, or branched once or more from a common base. Palisades sloughing off in dusty flakes to accumulate in small, grayish-tan heaps underneath stromata. Conidiogenous cells terminal, cylindrical, 10-20 μm long x 3 μm diam, hyaline to tan, covered terminally and laterally with denticulate to crateriform conidial secession scars indicating former sites of conidial attachment. Conidia produced holoblastically in sympodial sequence. Conidia hyaline, smooth, obovoid to ellipsoid, with flattened bases indicating former points of attachment to conidiogenous cell, 5-6 x 2-2.5 μm.

SPECIMEN EXAMINED AND CULTURED: PUERTO RICO: Luquillo Mts., El Verde, on dead branch, D. J. Lodge 415, 30.IX.1988 (JDR).

NOTES: The teleomorph of this fungus has characteristics of both *X. cubensis* and *X. allantoidea*. In stature and ascospore size it resembles the former species, in color the latter species. Dennis (1970) recognized the difficulty in delineating taxa of this group and put several species into synonymy with *X. papyrifera* [as *Xylosphaera papyrifera* (Fr.) Dennis]; *X. cubensis* was reduced to subspecies *cubensis* (Mont.) Dennis.

Cultures of this fungus bear flabellate stromata much like those of *X. cubensis*, but conidial color in mass tends to be tan rather than pink, in this characteristic resembling *X.* cf. *allantoidea* (see earlier herein). It is suspected that this fungus and others in this complex produce separate and distinct anamorphic and teleomorphic stromata. If field studies confirm these suspicions the anamorph described here should be considered a *Xylocoremium* Rogers.

Xylaria telfairii Berk. & Fr., Nova Acta Regiae Soc. Sci. Upsal. (ser. 3) 1, p. 127. 1851. Fig. 73.

Stromata cylindrical to clavate, stipitate, occasionally branched so that two fertile portions share a common stipe, fertile portions 1.5-3 cm x 4-5 mm, stipes narrow, strap-like, 1.7-4.5 cm x 1.5-3 mm. Exterior smooth, unwrinkled, with fine longitudinal cracks, manila-colored to buff (pale umber) overlying black layer. Interior white, corky, degenerating in fertile portion which becomes hollow with age. Perithecia globose, ca. 0.5-1 mm diam. Ostioles umbilicate, sometimes slightly raised. Asci 8-spored, cylindrical, stipitate, spore-bearing portions ca. 135 x 11 μm, stipes 95-100 x 3 μm, with apical ring bluing in Melzer's iodine reagent, coffin-shaped to rectangular, 7-10 μm high x 4 μm broad. Ascospores smooth, brownish-black, ellipsoid-inequilateral, concave on germ slit side, (19.5-)20-22(-22.5) x 6-7 μm, with straight inconspicuous germ slit ca. 2/3-3/4 spore-length.

Colonies covering Petri dish in ca. 2.5 wk, at first white, velvety, appressed, zonate, with finely lobed margins. Lobes at periphery of zones becoming raised above colony surface, developing into loosely-formed stromatal-like tufts ca. 1 cm x 1-2 mm. Slightly more robust, pale tan to orange-tan stromata occasionally developing, but remaining sterile. Colonies darkening from center outwards with an olive gray, velvety layer of hyphae. Surface hyphae usually tightly coiled. Reverse uncolored. No conidiogenous structures observed.

SPECIMEN EXAMINED AND CULTURED: FRENCH GUIANA: A. Y. Rossman, 3378 (JDR).

NOTES: Dennis (1956) considered *X. enterogena* to be a small form of *X. telfairii*. Cultures from collections referable to *X. enterogena* and *X. telfairii*, respectively, are nearly identical, thus adding support to Dennis' contention. See Notes on *X. enterogena* herein.

Xylaria tentaculata Berk. & Br., Grevillea 4:48. 1875. Figs. 66-71.

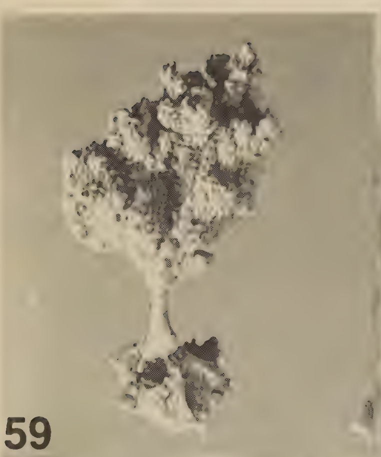
Stromata when immature bearing the anamorph on long, pale grayish tan, unbranched, tapering, tentacle-like appendages 0.5-2 cm long x ≤ 0.3 mm diam, bases attached to apex of stipe. Conidiogenous cells in palisades over surfaces of appendages, cylindrical, 20-30 x 5-6 μm, covered with conical conidial secession scars. Conidia hyaline, verruculose, subglobose, with flattened bases indicating former points of attachment to conidiogenous cells, 6-9(-10) x 4.5-5 μm. Stipes of stromata blackish brown, glabrous, cylindrical, 1-3 cm tall x 0.5-1 mm diam. Perithecia forming at base of tentacles which dehisce to leave denticulate pegs. Perithecial outlines prominent. Perithecia globose, ca. 0.5-0.75 mm diam, often collapsed around ostioles. Ostioles papillate. Asci 8-spored, cylindrical, short-stipitate, spore-bearing portions 120-150 x 9-11 μm, stipes 20-30 x 3-5 μm, with apical ring bluing in Melzer's iodine reagent, urn-shaped in optical section, 10 μm high x 6 μm broad. Ascospores smooth, brown, unicellular, ellipsoid-inequilateral, 20-22 x (6-)7-8 μm, with straight, spore-length germ slit and globose, hyaline noncellular appendage on each end.

Colonies covering Petri dish in ca. 2 wk, at first white, velvety, becoming floccose towards periphery; floccose patches thickening and forming pulvinate to subglobose sclerotium-like bodies of dense tissue which develop a thin black outer layer as colonies mature. Reverse uncolored. Stromata infrequently formed, usually near center of colonies, at first cylindrical, robust, exterior blackened except for white growing tip, interior fleshy, becoming spathulate after coming into contact with Petri dish lid, 2-4 cm tall x 2-4 mm diam, up to 1.5 cm broad at spathulate apex. No conidiogenous structures observed in culture.

SPECIMEN EXAMINED AND CULTURED: USA: Tennessee, Blount Co., Bote Mt. Trail area near Crib Gap, Cades Cove Rd., on soil and leaf mulch under mixed hardwoods, *Tsuga* and *Pinus*, D. E. Desjardin, 31.VIII.1986 (JDR).

NOTES: *Xylaria tentaculata* was described by Berkeley and Broome on what might have been an entirely anamorphic collection. Lloyd (1924) stated that there were no specimens bearing perithecia in the type collection, and that "There is no evidence that Berkeley ever saw the fertile form although his descriptions seem to fit it." Berkeley and Broome, however, described stromata as showing ostioles. Thus, there is the possibility that type stromata had teleomorphic structures, although perhaps immature. It is also possible that a part of the type was lost.

Figs. 59-65. Figs. 59 and 60. *Xylaria* sp. aff. *cubensis*. 59. Flabelliform coremium from culture, X 3.8. 60. Palisade of conidiogenous cells, X 2000. Figs. 61-63. *Xylaria microceras*. 61. Culture, X 1.4. 62. Conidiogenous cells with apical secession scars, X 2200. 63. Germinating conidia, X 2200. Figs. 64 and 65. *Xylaria arbuscula* (Canary Islands). 64. Conidiogenous cell with single secession scar evident, X 2250. 65. Conidium, X 3000. Figs. 60, 62-65 by DIC.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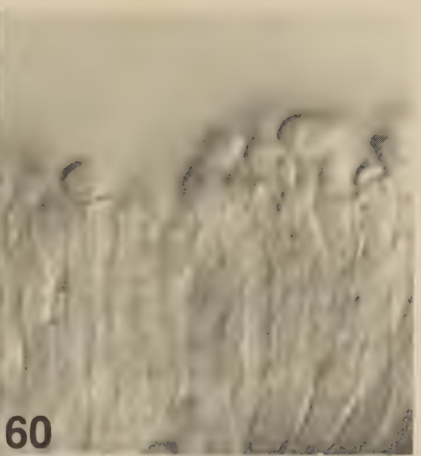
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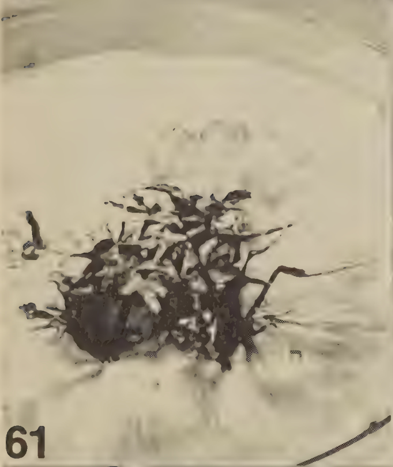
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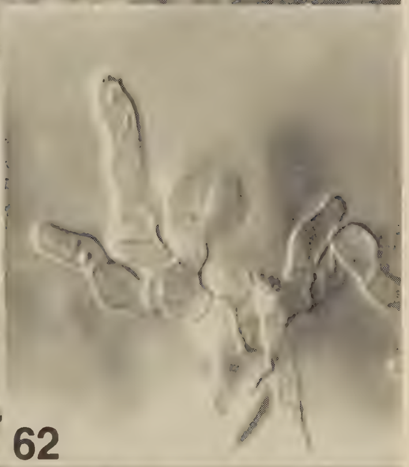
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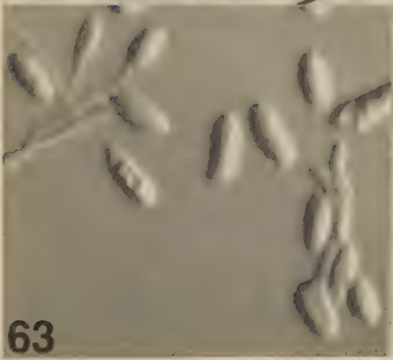
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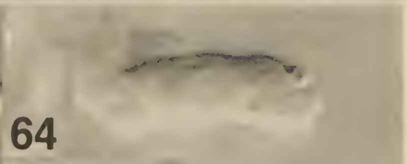
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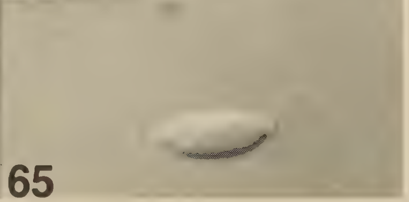
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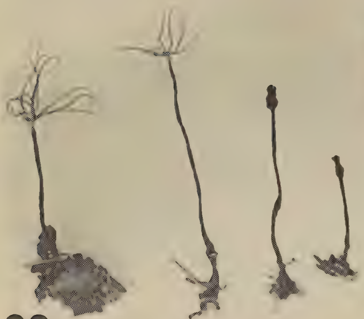
The developmental morphology, including perithecial formation, was elucidated in detail by Brown (1913) who showed that the conidia-bearing arms originated by the division of the apex of the young stalk. Brown described the conidia as "...hyaline, somewhat vacuolate, elliptical to pyriform with a rather prominent and slightly roughened spore wall" which is very similar to the conidial characteristics observed in the collection described above. Our description of the teleomorph is also similar to Brown's. Although no anamorph was produced in this culture, it was striking in the production of sclerotium-like structures and stromata that were very robust and several times the diameter of those in nature.

Penzigia cf. *indica* Rawla & Narula, Indian Phytopath. 37:312. 1984.
Figs. 50-58.

Stromata on surface of bark, solitary to cespitose, pulvinate, 4-6 mm diam x 2 mm tall, attached to substrate by a short, narrow central connective. Exterior dull black, warty, moriform, with remnants of a paler, tan to brown external layer remaining on surface in the form of small plates or scales. Interior white, fragile. Perithecia globose to subglobose, 1-1.5 mm diam. Ostioles papillate. Asci 8-spored, cylindrical, stipitate, spore-bearing portions 150-200 x 18-24 μm, stipes 60-100 x 5-6 μm, with apical ring bluing in Melzer's iodine reagent, massive, more or less cylindrical or with a slight central constriction, 12-14 x 6 μm. Ascospores brownish-black, ellipsoid, often with noncellular appendage on one end, smooth, (35-)36-40(-41) x 12-14 (-15) μm, with straight, full-length germ slit.

Colonies reaching edge of Petri dish in ca. 3.5 wk, at first white, velvety, faintly zonate, surface becoming irregularly rugose, covered with a black, carbonaceous layer. Reverse pale orange-tan. Stromata scattered over colony surface but most frequently forming at edge of Petri dish, 1-3 cm tall x 1-4 mm diam, cylindrical to capitate to spathulate, unbranched, or apex with multiple digitate projections, some of which develop further into branches. Capitate stromata developing perithecium-like projections which never mature to produce asci. Stromata initially white, then darkening to black except at the growing tip, eventually covered by a white or pale yellow layer on upper surfaces, which later bear conidiophores. Conidiophores upright in palisades, branched near base, white in mass, eventually sloughing off in flakes to reveal the blackened stromatal layer beneath. Conidiogenous cells terminal, cylindrical, 15-30 x 3.5-4.5 μm, covered with crateriform conidial secession scars. Conidia produced holoblastically in sympodial sequence. Conidia hyaline, smooth, narrowly ellipsoid to subcylindrical, with small, flattened bases indicating former points of attachment to conidiogenous cell, 6-7.5 x 2-2.5(-3) μm. Conidia germinating in culture.

Figs. 66-73. Figs. 66-71. *Xylaria tentaculata*. 66. Stromata, two on left bearing conidial appendages, two on right with perithecia, X 1. 67. Ascus tip in Melzer's reagent (arrow), X 1000. 68. Lower part of same ascus; left ascospore with germ slit evident (arrow), X 1000. 69. Culture, with sclerotium-like structures evident, X 0.8. 70. Conidiogenous cells with prominent apical secession scars, X 1200. 71. Conidium, X 2000. 72. *Xylaria enterogena*. Culture, X 0.55. 73. *Xylaria telfairii* culture, X 1.8. Figs. 67 and 68, 70 and 71 by DIC.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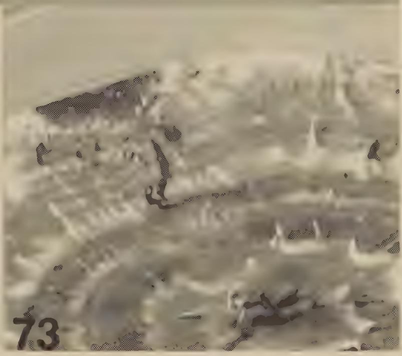
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SPECIMENS EXAMINED: FRENCH GUIANA: G. J. Samuels 4418, 4420 (BOTH CULTURED) (NY; JDR); INDIA: Bengal, Darjeeling, Tiger Hill, on dead angiospermous stumps, A. M. Narula 16235, 19.VIII.1980 (isotype in JDR).

NOTES: The two South American collections differ in a number of ways from Indian isotype material examined. Rawla & Narula (1984) described ascus tips of *P. indica* as inamyloid; ascus tips of our collections stain blue in Melzer's iodine reagent. We also noted that ascospores, although the same size as the isotype material, often were appendaged. Stromata of the South American material also tended to be more robust. As we have no cultures of type material from India, it is difficult to tell if these are regional variations, or if, in fact, these fungi are different subtaxa. Cultures are striking and definitely xylarioid, however, and if cultural features are found to be similar for typical Indian collections, this species should be removed from *Penzigia* and placed in *Xylaria*.

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FIRST RECORD OF CATENARIA AUXILIARIS IN ILLINOIS

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The soybean cyst nematode (*Heterodera glycines* Ichinohe), a major yield-limiting pest of soybean (*Glycine max* (L.) Merr.), is present in all counties in central and southern Illinois (Melton *et al.*, 1988). Carris *et al.*, (1989) found 71 species of fungi associated with cysts of the nematode in two Illinois fields. As reported herein, further investigations on the interactions of fungi and the soybean cyst nematode have revealed the presence of another cyst-inhabiting fungus, *Catenaria auxiliaris* (Kühn) Tribe, in Illinois.

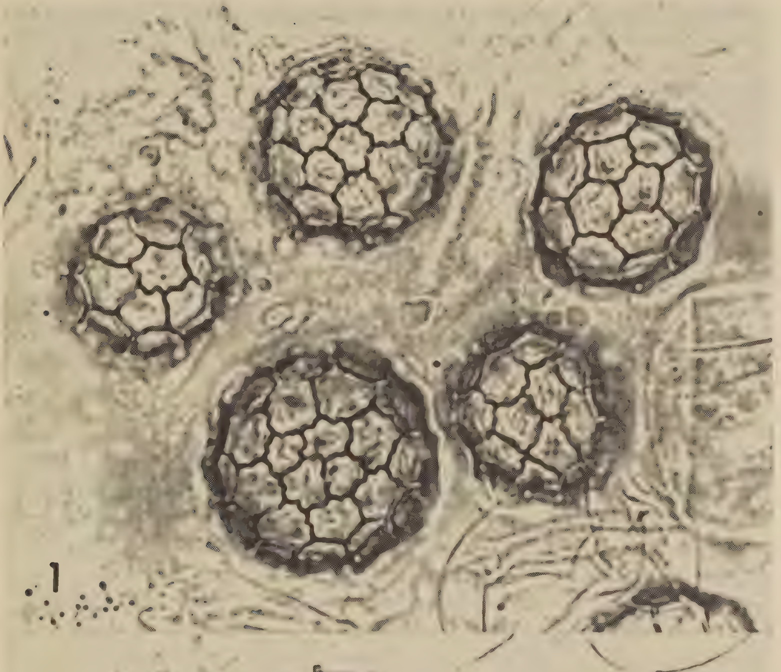
Catenaria auxiliaris has been reported as a parasite of female sugar beet cyst nematodes, *Heterodera schachtii* Schmidt, in England, the Netherlands, Germany, Sweden, Czechoslovakia and California (Tribe, 1977). Kerry and Crump (1977) observed the fungus as a parasite of the cereal cyst nematode, *Heterodera avenae* Woll., in England. Other host and geographical records include *H. avenae* in Australia (Stirling and Kerry, 1983), *Heterodera latipons* Franklin and *H. avenae* in Bulgaria (Stoyanov, 1982), and *Heterodera humuli* Filipjev in the Ukrainian SSR (Mikhajljukov, 1976). Crump *et al.*, (1983) observed the fungus in 0.7% of *H. glycines* cysts from one site in Tennessee, and 0.4% of *Heterodera zeae* Koshy, Swarup, and Sethi cysts from Maryland. The only report of the fungus from a host other than cyst nematodes is the observation of the fungus in a single larva of the large elm bark beetle, *Scolytus scolytus* F., in England (Doberski and Tribe, 1978).

The first record of *C. auxiliaris* in Illinois is based on the discovery of the fungus in cysts of *H. glycines* used in experiments to test several soilborne fungi for pathogenicity toward the nematode. *Catenaria auxiliaris* apparently was present in the nonsterile cyst-free field soil used in the experiment. Yellow (older, egg-producing) females of *H. glycines* were taken from greenhouse stock cultures maintained on soybeans (cv. Williams 82) in sterilized greenhouse soil mix (1:3 soil:sand). The females were placed in 7 cm-diam. clay pots in nonsterilized cyst-free field soil obtained from Kankakee Co., IL. After 1- and 2-week intervals the cysts were recovered from the soil by wet-sieving (Southey, 1970). Soil screenings were stored in tap water at 4 C for 10-11 days until cysts were mounted for microscopic observation.

Resting sporangia of *C. auxiliaris* were found in cysts examined after the 2-week interval in two replicates completed at different times. The resting sporangia were found in 4 of 154 cysts (2.6%) from the first replicate, and 1 of 132 cysts (0.7%) from the second replicate. A microscope slide mount of resting sporangia of the fungus has been deposited in ILLS. The resting sporangia (Figs. 1 and 2) were globose to subglobose, occasionally oblong, measuring 22-44 (-56) μm in diameter ($\bar{x}$ = 30.6 μm). The resting spores, which develop inside the sporangia (Tribe, 1977), were yellow-brown and had a mesh-like, reticulate wall.

To determine whether *C. auxiliaris* was present in the sterilized greenhouse soil mix, 306 brown cysts taken directly from stock cultures were observed microscopically. In addition, 165 yellow females were taken from stock cultures, returned to the sterilized greenhouse soil mix, and recovered after two weeks. *Catenaria auxiliaris* was not observed in these cysts, suggesting that the fungus was not present in the sterilized greenhouse soil mix. The yellow females of *H. glycines* added to the field soil apparently served to bait *C. auxiliaris* from the soil. The fungus probably occurred on some other host or substrate, since no nematode cysts were found in the soil.

Figs. 1 and 2. *Catenaria auxiliaris* resting sporangia. 1. Surface view in focus. 2. In optical section. Both photographs, x1000.



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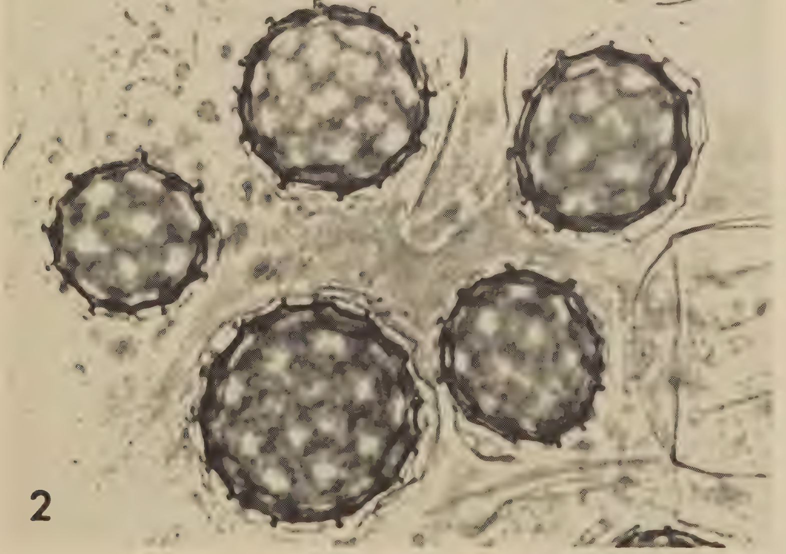

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The likely presence of this fungus on hosts other than cyst nematodes suggests that the host range is larger than previously believed (see also Doberski and Tribe, 1978). Knowledge of the host range of this cyst-inhabiting fungus may prove important in further investigations on *C. auxiliaris* as a potential biocontrol agent in the management of cyst nematodes.

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HALOPHYTOPHTHORA, GEN. NOV., A NEW MEMBER OF THE FAMILY PYTHIACEAE

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ABSTRACT

As a result of a comparative study of all species of _Phytophthora_ in culture at the American Type Culture Collection, (ATCC) Rockville, Maryland, most of the marine species are considered to be distinct enough to be assigned to a new genus _Halophytophthora_ gen. nov. which is similar to _Phytophthora_ de Bary in the production of zoospores within the sporangium proper but differs in the sporangial apical structure, the mode of zoospore emission and other morphological and cultural characters. The following species are transferred from _Phytophthora_ to _Halophytophthora_: _H_. _avicennae_, _H_. _bahamensis_, _H_. _batemanensis_, _H_. _epistomium_, _H_. _mycoparasitica_, _H_. _operculata_, _H_. _polymorphica_, _H_. _spinosa_ var. _lobata_, _H_. _spinosa_ var. _spinosa_ and _H_. _vesicula_.

Although Waterhouse (1973) included eight genera in the Family Pythiaceae of the Order Peronosporales, the most common of these genera undoubtedly are _Pythium_ Pringsh and _Phytophthora_ de Bary which are distinguished primarily by the fact that whereas differentiation of zoospores in _Pythium_ takes place in a vesicle usually at the tip of a discharge tube, zoospore of _Phytophthora_ are fully formed within the sporangium proper, and liberated at the apex with or without the formation of an evanescent vesicle (Alexopoulos & Mims, 1979). The genus _Phytophthora_ is further characterized by the non-septate hyphae branching at right angle with slight constriction at the point of origin, the sympodially branched sporangiophore bearing ovoid to obpyriform, papillate to nonpapillate sporangia, the production of amphigynous and/or paragynous antheridia and their parasitism on terrestrial plants (Hickman, 1958). However, since 1969, nine species and two varieties of _Phytophthora_ have been described from marine habitats and all except one which was mycoparasitic, were saprophytic on decaying leaves and roots in sea water

(Anastasio & Churchland, 1969; Fell & Master, 1975; Pegg & Alcorn, 1982; Gerrettson & Simpson, 1984). They were placed in the genus *Phytophthora* primarily based on the fashioning of zoospores within the sporangium proper. However, the sporangial apical structure and the methods of zoospore discharge are so unique that Waterhouse *et al*. (1983) excluded them from the genus *Phytophthora*.

As a result of a comparative study of all species of *Phytophthora* in culture at the American Type Culture Collection, Rockville, Maryland, we have arrived at a similar conclusion that these marine forms are distinct enough to be considered belonging to a new genus of the Pythiaceae based on the following reasons:

(1) Whereas zoospores of *Phytophthora* are always released naked or in a quickly evanescent vesicle, the marine forms displayed different methods of zoospore emission. Thus *P*. *vesicula* releases zoospores in a semi-persistent vesicle which ruptures by the inversion of an internal plug. Zoospores of *P*. *bahamensis*, *P*. *epistomium*, *P*. *mycoparasitica* and *P*. *spinosa* are liberated upon the ejection of a plug within a dehiscence tube. *Phytophthora* *operculata* discharges the zoospores by means of an apical operculum but *P*. *avicennae*, *P*. *batemanensis* and *P*. *polymorphica* usually release them from a persistent vesicle.

(2) The apex of sporangium of *Phytophthora* may be papillate, semi-papillate or non-papillate with a translucent, thick to very shallow apical thickening which eventually dissolves or becomes the evanescent vesicle. Although the sporangia of *P*. *vesicula* were described as papillate, the apex is occupied by a characteristic plug. The other marine species were described as nonpapillate, but unlike all other species of *Phytophthora* with nonpapillate sporangia, internal proliferation of sporangium was never observed and instead, the base of the empty sporangium was often conspicuously plugged.

(3) While the sporangia of *Phytophthora* are smooth-walled and typically limoniform, obpyriform, ovoid to ellipsoidal, the sporangia of *P*. *spinosa* and *P*. *mycoparasitica* have spines on the surface and the sporangial shape of most marine species exhibit a wide variety of forms unknown for the genus.

(4) With the exception of the rare occurrence of spherical oogonia with paragynous antheridia in the original description of *P*. *vesicula*, the sexual stage is unknown in all marine species. The amphigynous antheridium characteristics only of *Phytophthora* and the monotyptic *Trachysphaerella* (Waterhouse, 1973) has never been found.

(5) The great majority of Phytophthora species have hyphal diameters measuring 5-8 μm. Blackwell (1949) stated that the commonest diameter of young and vigorously growing hyphae was 5 to 8 μm while Waterhouse (1973) determined the average hyphal diameter for the genus as 6 μm. The marine forms shows a much wider range in hyphal diameters. The very narrow hyphae of P. bahamensis and P. epistomium (1-3 μm), and the broad hyphae of P. spinosa var. lobata and P. operculata (10 and 10-12 μm, respectively) are either well below or well above the norm for the genus Phytophthora. In most cases, hyphal branching was very irregular, unlike the free branching at wide angles characteristic of most Phytophthora spp.

(6) Most marine species produce slow growing (1-5 μm per day at 20 °C) compact, appressed, finely rosette or petaloid colonies on clarified V8 juice agar medium, different from the floral colonies with larger sectors and various degree of fluffiness, produced by some fast growing Phytophthora spp.

(7) Most Phytophthora species produce a characteristically firm rot in apple fruit (Ribeiro, 1978), but the marine forms produced a soft rot similar to that due to Pythium (Luo et al., 1987).

(8) Nearly all species of Phytophthora are plant pathogens (Waterhouse, 1973). With the exception of P. mycoparasitica which is parasitic on other marine fungi, all marine forms are primarily saprophytic.

According to Waterhouse (1973), the Family Pythiaceae consists of eight valid genera: Pythium, Phytophthora, Trachysphaera Tabor et Bunting, Zoophagus Sommerst, Diasporangium Höhnk, Sclerophthora Thirum. et al., Peronophythora Chen ex Ko et al., and Pythiogeton Winden. While Peronophythora has been reclassified in a family Peronophythoraceae (Ko, et al., 1978) Sclerophthora has been transferred to Peronosporaceae (Shaw, 1978). The descriptions of Diasporangium and Zoosphagus are incomplete and the inclusion of these genera in the Pythiaceae is only provisional. Trachysphaera and Pythiogeton are considered distinct from Phytophthora based on the spiny conidia forming no zoospores in the former and irregular, large sporangia with a long discharge tube in the latter. Undoubtedly, the marine species are at least as distinct, if not more distinct from Phytophthora as Trachysphaera and Pythiogeton and a new genus name is clearly warranted. We propose Halophytophthora to reflect its similarity with the genus Phytophthora in the production of zoospores within the sporangium and to highlight their significant differences.

Halophytophthora Ho et Jong, gen. nov.

> **Fungus marinus submergus, saprophyticus vel parasitus. Hyphae hyalinae, ramosae, teretes, demum raro septatae, 1-6 μm diam. Chlamydosporae ratae vel non exhibitae. Sporangiophora intramatricalia aut extramatricalia. Sporangia haud decidua, plures formas habent, lageniformia, obpyriformia ad multilobata, auricula, bursiformia, globsa ad ovata, non papillata ad papillata. Zoosporae in sporangio effectae, ubi incystatae vel vesiculam aliquando migrantes. Vesicula absens vel praesens, persistans ad subpersistans, fistulan emissionis efficiens inversione obturamenti interioris. Tubus dehiscens prominens epistomio. Oogonia rata vel non exhibita, trevia, globsa, hyalina, rubida in aetata. Antheridia paragyna. Oosporae unicae, fulvae in aetate, parietibus crasis, levia, globosa.**

Mycelium saprophytic or mycoparasitic in sea water. Hyphae hyaline, smooth to irregular, 1-2 μm wide, with or without swellings, coenocytic. Sporangia non-deciduous, shapes highly variable, spherical, ovoid, obpyriform, auricular, bursiform, lageniform, obpyriform to multilobed, under 50 to over 100 μm long, non-papillate to papillate without translucent apical thickening, sporangial wall smooth or spiny. Zoospores are formed within the sporangium and released in a persistent vesicle or a semi-persistent vesicle ruptured by the inversion of an internal plug; by the ejection of a plug within a dehiscence tube or by the opening of an apical operculum. Chlamydospores rare or unknown.

Oogonia absent or rare, smooth, globose, hyaline, dark brown with age (32.1-) 46.3 (-59.7) μm with paragynous antheridia (15.0-) 20.5 (-25.0) μm x (7.5-) 9.0 (-12.5) μm and single smooth thick walled spherical oospore (29. 7-) 42.2 (-49.4) μm, yellowish brown with age.

Type species. *Halophytophthora vesicula* (Anastasious et Churchland) Ho et Jong, comb. nov.

= *Phytophthora vesicula* Anastasiou et Churchland. Can J. Bot. *47*: 251. 1979.

Additional species. --

Halophytophthora avicennae (Gerrettson-Cornell et Simpson) Ho et Jong, comb. nov.

= *Phytophthora avicennae* Gerrettson-Cornell et Simpson. Mycotaxon *19*: 453. 1984.

Halophytophthora bahamensis (Fell et Master) Ho et Jong, comb nov.

= *Phytophthora bahamensis* Fell et Master. Can. J. Bot. 53: 2908. 1975.

Halophytophthora batemanensis (Gerrettson-Cornell et Simpson) Ho et Jong, comb. nov.

= *Phytophthora batemanensis* Gerrettson-Cornell et Simpson. Mycotaxon 19: 453. 1984.

Halophytophthora epistomium (Fell et Master) Ho et Jong, comb. nov.

= *Phytophthora epistomium* Fell et Master. Can. J. Bot. 53: 2908. 1975.

Halophytophthora mycoparasitica (Fell et Master) Ho et Jong, comb. nov.

= *Phytophthora mycoparasitica* Fell et Master. Can. J. Bot. 53: 2908. 1975.

Halophytophthora operculata (Pegg. et Alcorn) Ho et Jong, comb. nov.

= *Phytophthora operculata* Pegg et Alcorn. Mycotaxon 16: 99. 1982.

Halophytophthora polymorphica (Gerrettson-Cornell et Simpson) Ho et Jong, comb. nov.

= *Phytophthora polymorphica* Gerrettson-Cornell et Simpson. Mycotaxon 19: 453. 1984.

Halophytophthora spinosa var. *lobata* (Fell et Master) Ho et Jong comb. nov.

= *Phytophthora spinosa* var. *lobata* Fell et Master. Can. J.Bot. 53: 2908. 1975.

Halophytophthora spinosa var. *spinosa* (Fell et Master) Ho et Jong, comb. nov.

= *Phytophthora spinosa* var. *spinosa* Fell et Master. Can.J.Bot. 53: 2908. 1975.

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A MONOGRAPH OF THE DISCOMYCETE GENUS STROSSMAYERIA (LEOTIACEAE), WITH COMMENTS ON ITS ANAMORPH, PSEUDOSPIROPES (DEMATIACEAE)[1]

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ABSTRACT

Sixteen species are recognized and characterized, of which 9 are new combinations (*Strossmayeria alba, S. alnicola, S. atriseda, S. bakeriana, S. confluens, S. immarginata, S. introspecta, S. jamaicensis, S. sordida*), and 5 are new species (*S. dickorfii, S. japonica, S. nigra, S. notabilis, S. ochrospora*). A dichotomous key to the included species is provided, as well as a map of the world distribution of the recognized species of the genus, which has also been called *Leptobelonium* and has regularly been confused with *Gorgoniceps*. A *Pseudospiropes* anamorph (in early publications referred to *Helminthosporium*) is associated with all but one species (*S. nigra*). All species occur on woody substrates (including some larger bamboos and woody parts of fruits) as saprophytes. The tiny apothecia (usually less than 1 mm diam) are easily overlooked, and their presence is often only detected by noting the anamorph forming extensive, black patches on the substrate. The genus is characterized by a rare phenomenon in Ascomycetes: ascospores (and some apothecial tissues as well) that turn blue in iodine mounts. The ascus pore is non-reactive in iodine.

KEYWORDS: *Strossmayeria, Leptobelonium, Gorgoniceps, Pseudospiropes, Helminthosporium,* Inoperculate Discomycetes, Leotiaceae, Dematiaceae

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[1] Based primarily on the senior author's dissertation presented to the Graduate School of Cornell University, Ithaca, NY, in partial completion of the requirements for the Ph.D. degree conferred January, 1990.

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INTRODUCTION

The objective of this study is to monograph the genus *Strossmayeria* Schulzer (1881), for which no monograph has previously been published, by delimiting the genus and determining how many species belong in it. The genus is most unusual in possessing ascospores that blue in iodine mounts, a feature that occurs in very few other Ascomycetes and perhaps no other Discomycetes. Another feature of major interest is that it is the only Discomycete genus known to possess a dematiaceous anamorph belonging to *Helminthosporium* sensu lato. The anamorphs which connect to *Strossmayeria* are now more correctly referred to the genus *Pseudospiropes* Ellis (1971) (Iturriaga, 1984). An earlier study was made of the type specimens of species assigned to *Strossmayeria* (Iturriaga, 1984a). Of the seven species that had previously been assigned to the genus, three were excluded (Iturriaga, 1984).

Strossmayeria belongs to the order Helotiales, family Leotiaceae (Discomycetes). Its members are saprophytes on wood, frequently decorticated wood, and are almost always found in association with their anamorphs. This constant association was noted long ago, as pointed out by Iturriaga & Korf (1984). Whether the discomycete and the hyphomycete represented different morphs of a single species or one fungus parasitic on another was long a subject of speculation. Single-ascospore cultures of five collections referable to at least two species of *Strossmayeria* consistently yielded cultures belonging to *Pseudospiropes,* proving these to be teleomorphs and anamorphs, respectively, of the same holomorphs (Iturriaga & Korf, 1984). Production of apothecia of any species of the genus in axenic culture has yet to be achieved, despite repeated attempts on a variety of natural and artificial substrata and of environmental conditions.

For this monograph most of the available specimens of *Strossmayeria* from different parts of the world were studied. Since most of the type specimens of species that have been assigned to the genus *Strossmayeria* are from temperate areas, special effort was devoted to collecting in tropical and subtropical areas and to studying dried herbarium specimens from these areas. A major objective was to collect and/or obtain dried herbarium specimens collected in as many microecological niches and geographical environments as possible.

MATERIALS AND METHODS

This study was performed with dried herbarium specimens and with fresh specimens collected by other mycologists and by ourselves in tropical, sub-tropical, and temperate regions of Africa, Asia, Australasia, Europe, North America, and South America. Type specimens of species assigned to the genus *Strossmayeria* and to many other genera (*Belonidium, Belonium, Gorgoniceps, Leptobelonium,* etc.), which by the description could possibly fall in this genus, were borrowed from many herbaria. Herbaria in the United States, Canada, and Europe were visited in order to search under different generic names for collections possibly assignable to *Strossmayeria* or *Pseudospiropes*. When possible, cultures were made from collected specimens. From some areas in which it was not possible to collect, specimens from herbaria in the area were borrowed.

Field collections, consisting of substrate with attached apothecia, were placed in small paper bags or glassine envelopes. Many specimens were later cultured. When isolations were done in the field, the specimens were prepared for deposit in the herbarium by being transferred to glassine envelopes and placed in a gas-heated or electric-heated portable field drier for approximately 10 hours. In other instances, specimens were returned to the laboratory, where the isolations were done, and specimens were then placed in a herbarium drier at 40 C for 1 day.

For obtaining cultures of *Strossmayeria,* 50 mm diam plastic Petri dishes with 2% water agar containing chloramphenicol and streptomycin[4] were used. A small block of agar was removed from the center of the dish and attached to the inside of the lid, near the edge, with a sterile scalpel. An apothecium was placed upright on this agar cube, where it would adhere, and the lid was replaced so that the hymenium of the apothecium faced the agar. Every few hours the agar beneath the apothecium was examined for ascospores. For these observations, the surface of the agar in the Petri dish, sealed with Parafilm, was scanned under a dissecting microscope at a low (× 25) magnification. If ascospores were present, the area was marked by scratching a circle on the exterior of the bottom of the dish, and the lid was rotated, so that newly discharged ascospores would not land among those previously discharged. This process was repeated until ascospores were discharged sufficiently at some distance from each other so they could easily be picked up individually.

Ascospores were then transferred with a fine needle, while focussing on them at × 40 magnification. Each ascospore was placed in an individual Petri dish with Difco Bacto corn meal agar (CMA), and sealed with Parafilm. The fungus was permitted to grow under ambient light at room temperature.

Dried specimens were prepared for microscopy as follows. They were first rehydrated by placing a drop of 95% ethyl alcohol, followed by one or two drops of distilled water, on the specimen. The portion of the specimen selected consisted of a few representative apothecia, one to be sectioned and the others to be squashed, attached to their substrate. One apothecium with 1-2 mm^2 of substrate was removed and placed carefully inside a small slit made in a cube of water agar, to serve as support. This cube was then placed carefully on the freezing stage of a sliding microtome, in a position such that the point of attachment of the apothecium would be the first thing to be touched by the blade. The cube was covered by 50% aqueous commercial mucilage, frozen, and 15 μm vertical sections were made. Sections were removed from the blade with a small, wet brush and placed on a microscope slide, where they were left to air-dry. Median sections were chosen under the dissecting microscope, and after a drop of water was added, each of the sections was transferred with an insect pin to a slide to be mounted in soluble blue 706–lactic acid,[5] 2% aqueous KOH followed by 1% aqueous phloxine, or Melzer's reagent[6] without KOH pretreatment. For each specimen, squash mounts and sections were mounted in each of the three reagents and in water for observation of structures, tissues, and reactions.

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[4] 20 g agar, 1000 ml water, 300 mg chloramphenicol, autoclaved at 15 lb pressure for 20 min; when cooled to 40 C 7.5 mg streptomycin sulfate added.

Melzer's reagent was used to observe the amyloid reaction of the ascospores and ectal excipulum. This reaction is characteristic of the genus. It will be referred to as "J+" throughout the text, and indicates that the tissue or structure turns blue when exposed to the Melzer's reagent. This reagent was chosen after comparing the intensity of the J+ reaction in Lugol's solution,[7] IKI,[8] and Melzer's reagent, with tissues rehydrated in 2% KOH, 10% KOH, or water. Melzer's proved to be the reagent in which the amyloid reaction was seen most clearly.

Congo red was used as a stain for observing ascus walls. This technique was devised by Imshaug[9] (pers. comm. to R. P. Korf) for demonstrating double walls in lichens.

KOH pretreatment tests were performed with 2% and 10% KOH, to see if rehydration of the tissue with either of these KOH concentrations caused variation in the presence or intensity of the J+ reaction of the tissues and structures, compared with rehydration with water.The variation in the reaction with and without KOH pretreatment has been recorded by different authors (Kohn & Korf, 1975; Nannfeldt, 1976; Baral, 1987). This comparison was done with several collections, but no differences associated with KOH concentration were observed. The same J+ reaction of the ascospores and ectal excipulum occurred with water and with 2% or 10% KOH pretreatment. Therefore subsequent rehydration was done with water. This had an additional advantage, because we had observed that when KOH rehydration was used, extreme swelling of the gel layer covering ascospores and conidia occurred.

Soluble Blue 706–lactic acid and KOH–phloxine were used to observe structures and tissues in sectioned and squashed material. Both, due to their properties as cytoplasmic stains, proved useful in ascertaining numbers of septa in the ascospores.

Whenever possible 30 measurements were recorded for each kind of structure for each specimen examined. All structures were measured in a straight line between apex and basal point, or between the two widest points. Curves made by the structures were not taken into account. The thickness of the gel layer was measured at the side of the ascospore or conidium, not at the tip, where it is usually thicker. Only asci that contained mature ascospores were measured. Conidiophores were measured at their widest part, and at their base.

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[5] 0.05 g Soluble blue 706 (Hopkins & Williams, "Revector") [Poirrier's Blue], 30 ml lactic acid.

[6] 100 g chloral hydrate, 5 g KI, 1.5 g Iodine, 100 ml water.

[7] 2 g KI, 1 g Iodine, 300 ml water.

[8] 1 g KI, 1 g Iodine, 100 ml water.

[9] 1 g Congo red, 100 ml distilled water. Stain for a few minutes on slide, heat slightly by passing slide over flame 10 times, add one drop of 0.1% aqueous HNO_3, add cover slip and observe under microscope.

Structures were measured and drawn with a calibrated ocular micrometer in an Olympic standard research microscope equipped with a Wild drawing tube. Structures were measured in Melzer's reagent or Soluble Blue 706–lactic acid. Photomicrographs were made with a camera mounted on a Zeiss WL microscope. Colors of structures are given for rehydrated material, unless otherwise specified.

Terminology used follows Korf (1952, 1973). Abbreviations of herbarium names follow *Index Herbariorum* (Holmgren, et al., 1981). Specimens in the personal herbarium of Professor Richard Korf are marked "R.P.K." Abbreviated literature citations follow *Botanico-Periodicum-Huntianum, B-P-H* (Lawrence, et al., 1968) and *Taxonomic Literature* (Stafleu & Cowan, 1976-1988). Throughout this monograph, the *International Code of Botanical Nomenclature* (Greuter, et al., 1988) has been followed.

The sign (!!) indicates that holotype, neotype, or isotype material has been examined. The sign (!) indicates that syntype, paratype, or other authentic material has been examined.

A question mark before a species name means material has not yet been examined, though placement of the name in the synonymy is probable.

Species names placed inside square brackets have not been validly published.

Specimens examined are cited with the data exactly as they appear on the packet label, except that information that is enclosed in square brackets is either from the description or from the herbarium where the specimen is housed. Collections are separated in the listings by semicolons.

Other abbreviations used are HT for holotype, IT for isotype, PT for paratype, and NT for neotype.

MORPHOLOGY OF *STROSSMAYERIA*

Strossmayeria Schulzer is a genus of sub-sessile to sessile inoperculate discomycetes. The genus is assigned to the order Helotiales, family Leotiaceae. Its species are saprophytes on decorticated wood, or rarely on large grasses and bamboos, or woody parts of fruits.

1. APOTHECIA

The apothecia are usually turbinate (though in a few species the shape is discoid or discoid to turbinate), sub-stipitate to sessile, and connected to

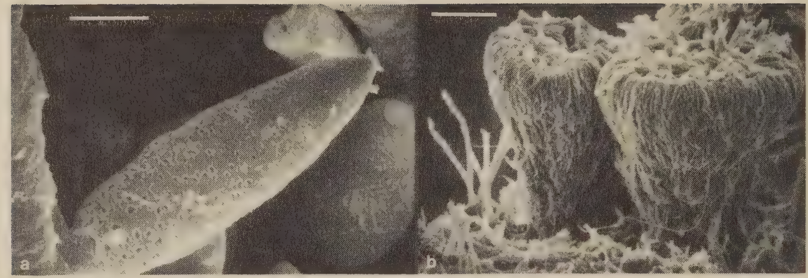


Figure 1. **Scanning electron micrographs of conidia and apothecia of *Strossmayeria introspecta*,** CUP 59716. **a,** Conidia of *Pseudospiropes* anamorph of *S. introspecta,* borne on conidiophore (left), scale bar = 5 µm. **b,** Apothecia, with conidiophores arising from basal mycelium, scale bar = 50 µm. Both SEM micrographs from unfixed, freeze-dried material.

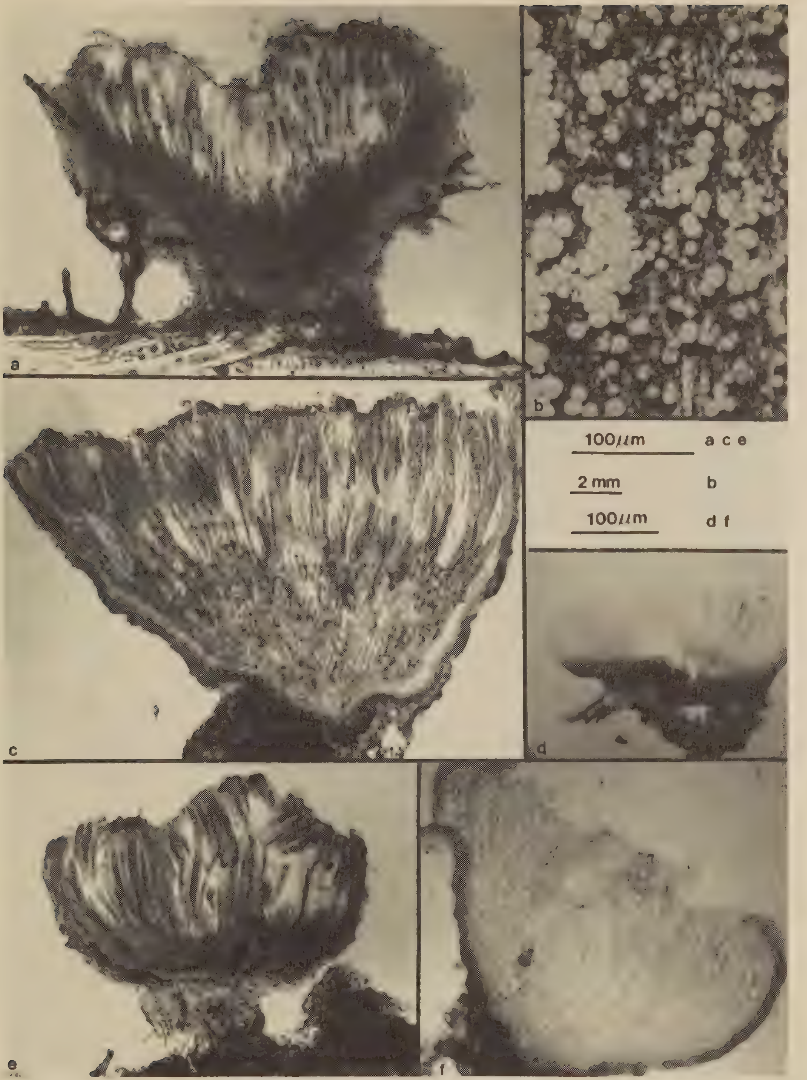
the substrate by a small point of attachment. They range usually from 0.2 to nearly 1 mm in diameter, but in *S. atriseda* the apothecia reach more than 1 mm in diameter (Fig. 1b). The apothecia can be solitary, gregarious, and very frequently confluent. When confluent, the apothecia lose their individuality, and two or many merge together Fig. 2b). They are usually pale colored externally, lighter toward the apex and darker toward the base of the receptacle. The upper part of the receptacle is usually concolorous with the disc, or the disc may be slightly paler. The disc can be white, cream colored, yellow, beige, or grayish to pearl-colored. *S. ochrospora* has light brown apothecia. Two species, *S. atriseda* and *S. japonica,* have completely dark brown apothecia, and *S. nigra* has black apothecia. The disc of all species is smooth to slightly granulose or pruinose, but this character varies according to environmental conditions and the state of the specimen, and is not due to variation among species.

A ring left on the base of the apothecia when removed from substrate resembles the ring observed in the genus *Calycellina* Höhnel.

2. ECTAL EXCIPULUM

The ectal excipulum is composed of textura oblita in most cases (in *S. nigra* it is textura oblita to porrecta), formed by rectangularly shaped elongated cells, with a thin gel layer between them (Fig. 3a-c). This gel layer has a "glassy" appearance when seen under the microscope. A similar gel layer surrounds nearly all structures of this fungus. In a longitudinal section, it is frequently difficult to see the difference between

Figure 2. **Apothecia: a, *Strossmayeria alba,*** HT; **b, f, *S. introspecta,*** CUP 59713; **c, *S. notabilis,*** HT; **d, *S. bakeriana,*** *S. ostoyae* HT; **e, *S. basitricha,*** *G. pilatii* HT.


a
b
100 µm a c e
2 mm b
100 µm d f
c
d
e
f

the inner ectal excipulum and the paraphyses in the hymenium, since they are very similar. The external ectal excipulum has the same colors as the apothecium, the upper part usually being white, cream, or beige, and the basal part being concolorous with the upper part or turning brown toward the base, one third of the way down the apothecium or just near the point of attachment. The inner ectal excipulum is hyaline. The ectal excipulum is J+, blueing throughout usually but in a few cases not blueing homogeneously. The intensity of the blue reaction varies but is not a character for distinguishing species. The surface of the apothecium is smooth, and this is well seen in section (Fig. 2), since the cells of the ectal excipulum are arranged in a palisade, with the axis of the cells parallel to the outer surface of the apothecium. The excipulum at the base of the apothecium is composed of round to irregular dematiaceous cells. The medullary excipulum is indistinguishable, and the small amount of tissue that can sometimes be seen is usually referred to as a subhymenium of textura intricata, also hyaline.

3. PARAPHYSES

Paraphyses are long and slender, simple or divided, septate or not, with swollen tips, hyaline, and the same height as the asci or a little longer. At times they may produce phialides bearing phialospores.

4. ASCI

Asci are usually clavate, or saccate in the case of several species (Fig. 3d-f, 8-11, 13, 15-19, 22-24). They are hyaline but have dextrinoid contents when young. The dextrinoid reaction is seen in Melzer's reagent. When the asci are immature, the dextrinoid reaction is light, and asci appear light brown. This color becomes darker when spores are forming and are young (with a few septa). When asci and ascospores are mature (the spores fully septate), the brown color is seen in some cases, but when the ascus lumen is completely occupied with the ascospores, this reaction disappears, or at least is hidden because of the strong blueing of the ascospores that fill the ascus. The dextrinoid reaction is not evident in mature asci that have discharged their ascospores. Asci arise from croziers or repeating croziers, which in most cases can be seen with no difficulty, and are unitunicate though they have a thick, very evident wall. Because of this thick wall, and because *Strossmayeria* connects with *Pseudospiropes,* which has thick-walled dematiaceous conidia, we suspected that the ascus might be bitunicate. A technique devised by Prof. Henry Imshaug (obtained by pers. comm. to Dr. Richard P. Korf) using Congo red as a stain for demonstrating double walls in lichens was used. We saw no bitunicate asci, and concluded that *Strossmayeria* has unitunicate asci.

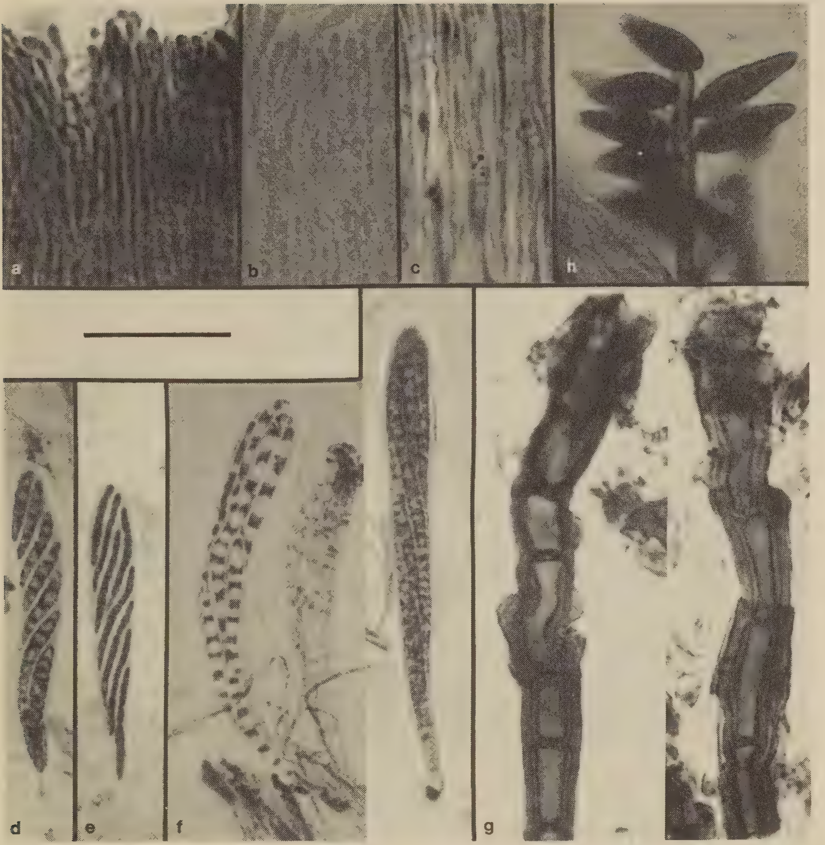


Figure 3. **Ectal excipulum, asci, and conidiophores: a-c, ectal excipulum. a, *Strossmayeria bakeriana,*** *S. ostoyae* HT; **b, c, *S. notabilis,* b,** CUP-VE 4336; **c,** IA 380550 (Martin 6067). **d-f, asci. d, *S. atriseda,*** HT; **e, *S. confluens,*** R.P.K. 2017 [ex HT]; **f, *S. notabilis,*** HT. **g, h, conidiophores. g, *S. atriseda,*** HT; **h, *S. introspecta,*** CUP 59716. Scale bar = 20 µm for **a, b, c, g,** = 50 µm for **d, e, f, h.**

5. ASCOSPORES

Ascospores are usually cylindrical-clavate, with the broad end toward the apex of the ascus (Fig. 4). In *S. atriseda,* the ascospores are subfusoid. Ascospores are hyaline, but in *S. ochrospora,* in which the lateral and septal walls are pale brown, the ascospore is pale ochraceous brown.

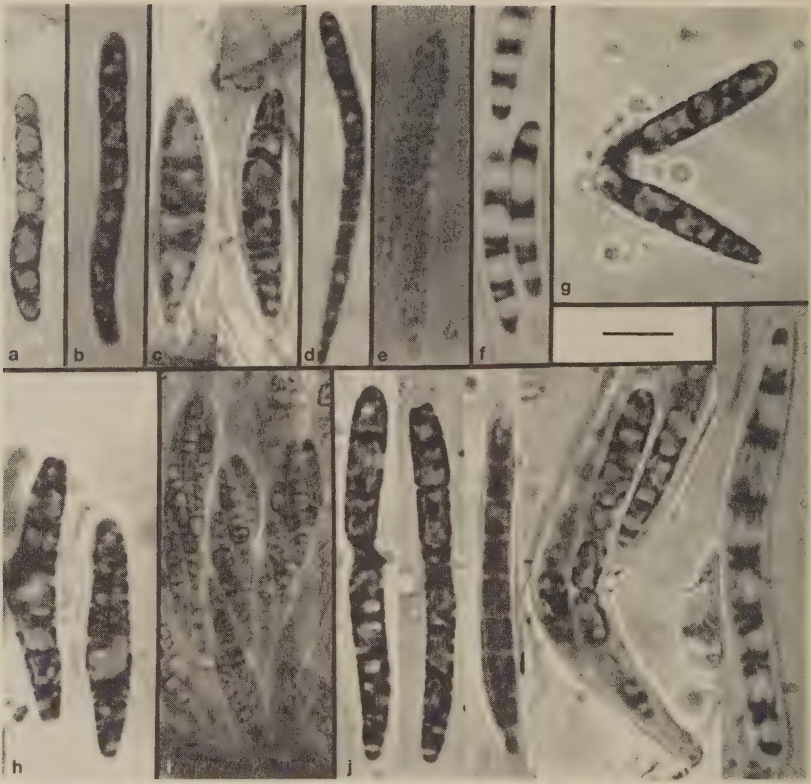


Figure 4. **Ascospores of different species: a.** ***Strossmayeria alba,*** HT; **b,** ***S. alnicola,*** HT; **c,** ***S. atriseda,*** HT. **d,** ***S. bakeriana,*** *S. longispora,* HT; **e,** ***S. confluens,*** R.P.K. 2017 [ex HT]; **f,** ***S. introspecta,*** CUP 59716; **g,** ***S. sordida,*** lectotype; **h, i,** ***S. jamaicensis,*** R.P.K. 3019 [ex HT], **h,** note enlarged refractocells, **i,** asci containing ascospores; **j,** ***S. notabilis,*** note disintegrating cells, first three spores and ascus containing spores IA 380550 (Martin 6067), right hand spore HT. Scale bar = 10 µm, except **i** = 25 µm.

Ascospores can be biseriate, but are most frequently multiseriate, arranged in a helix in the ascus. When mature, the ascospores are usually three-septate in *S. introspecta,* four-septate in *S. immarginata* and four- to five-septate in *S. atriseda,* three- to seven-septate in *S. dickorfii,* and mostly 7-septate in the remainder of the species. The cells in the ascospore are usually uniform, but in some of the tropical species certain cells have refractive contents different from the other cells of the same ascospore. These cells do not turn blue in Poirrier's Blue. The refraction is also evident in 2% KOH, and, less so, in Melzer's reagent. These cells are here termed "refractocells." They are present in *S. confluens, S. jamaicensis,*

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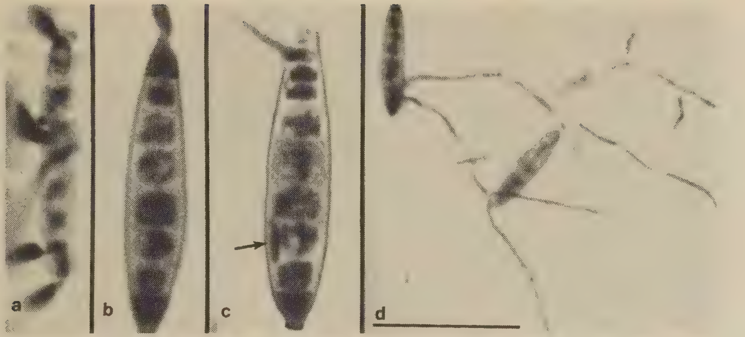


Figure 5. **Germinating ascospore and conidia: a,** ***Strossmayeria basitricha,*** germinating ascospore, CUP 61824; **b-d,** ***S. bakeriana,*** CUP 59717, germinating conidia. **b, c,** one day after discharge on agar (arrow shows internal germination hypha); **d,** three days after discharge on agar. Scale bar = 20 µm for **a, b, c,** = 50 µm for **d.**

and *S. sordida.* In *S. jamaicensis* the refractocell is enlarged. Some tropical species such as *S. confluens* also have cells that disintegrate. These cells, termed in this paper "disintegrating cells," are located in the ascospore and leave an empty space where the ascospore bends and later breaks, leaving short (2-, 3-, or 4-celled) ascospore segments (fig. 4g, j).

Ascospores in all species are surrounded by a gel layer. This layer in temperate species is usually smooth and always less than 1.5 µm thick. For tropical species the gel layer is thicker, usually verrucose, as in *S. confluens,* but smooth in *S. sordida.*

The amyloid (J+) reaction of the ascospores is characteristic of this genus and occurs in all the species. The blue reaction of the ascospores is generally lighter than that of the ectal excipulum. The length of time this reaction lasts is not clear. In some cases it shows immediately after the drop of Melzer's reagent is added, and then it disappears. Sometimes after disappearing, if more Melzer's reagent is added, the reaction is seen again. In other cases, the reaction is seen for hours and may or may not be recoverable by adding more reagent. Similar variability occurs in duration of the J+ reaction of the ectal excipulum, though the way ectal excipulum and ascospores react to the reagent is not always the same.

Germination of ascospores both inside the ascus and after discharge is quite frequent. This germination occurs by formation of a germ tube in all cases observed in European material. In North American species, in many instances ascospores germinate forming an apical phialide and phialospores, but occasionally basal and lateral phialides may also form (Fig. 5a). Germination by formation of germ tubes was also observed in North American species, but has rarely been observed in tropical material.

6. ANAMORPH

The anamorph of species of *Strossmayeria* is always a *Pseudospiropes* (Iturriaga & Korf, 1984). These morphs may or may not occur together in nature. The apothecia seem to occur at particular times of the year, and when they are found, the anamorph is almost always present. The condition of the anamorph varies, however. Very frequently conidiophores but no conidia are present, indicating that the time of conidial production was prior to the time of collection. Frequently the anamorph is found by itself with no apothecia.

Pseudospiropes is a dematiaceous, wood-inhabiting hyphomycete. The conidiophores (Fig. 3, g-h) are macronematous, mononematous, arising from a mass of rounded or elongated brown cells, simple, slightly flexuous or flexuous, thick-walled, and septate. All cells are dark brown except the conidiogenous cells, which are lighter and located toward and at the apex of the conidiophore. The conidiophore bears conspicuous cicatrized scars, that protrude grossly in *P. nodosus,* but are smaller and less protruding in *P. simplex* and other species. These scars turn darker and thicker as the conidiophore becomes older, due to more wall deposition. The conidiogenous cell is polyblastic, integrated, usually terminal, sympodial or percurrent, and also bears scars that are lighter than the conidiophore. The base of the conidiophore is swollen. The conidiophore is also surrounded by a gel layer that stains blue in Soluble Blue 706-lactic acid. Neither this gel nor any of the gel layers seen surrounding *Strossmayeria* ascospores or conidia of *Pseudospiropes* stain in Melzer's reagent. Conidia are usually fusiform, truncate at the base and tapering toward the apex, though they may be fusiform with one flat side in the anamorph of *S. dickorfii* and *S. jamaicensis,* and obclavate in *S. notabilis*. In some cases the basal cell of the conidium is a pedicel-like cell, as in *S. introspecta* (Iturriaga and Israel, 1985). There are characteristic dark cells in the conidia of some species. These may be basal, basal and apical, below the basal and/or apical cell, or central. In addition to or instead of dark cells, dark septa occur quite frequently in the conidia, usually as the basal and apical septa, or close to them. In one species, *S. josserandii,* a characteristic darker thickening around the septal pore in the conidia is found invariably, and this structure is referred to here as a "torus" (Fig. 6g, 21a-b). The conidial wall surface is always pitted (Fig. 1a) and markings on the surface show clearly in transmission electron microscopy (TEM) and scanning electron microscopy (SEM) photographs (Iturriaga & Israel, 1985). The wall of the conidium is up to 2 μm thick and multilayered. More than 8 wall layers were shown by them in TEM micrographs of one species of *Pseudospiropes*. Under the light microscope, the cell lumen is clearly seen, and it is very small compared to the conidial dimensions. Most of the conidium is occupied by the wall. Like the ascospores, conidia also are surrounded by a gel layer. Under some conditions this layer forms an apical thickening that is referred here to as a "bleb." This is best seen under SEM.

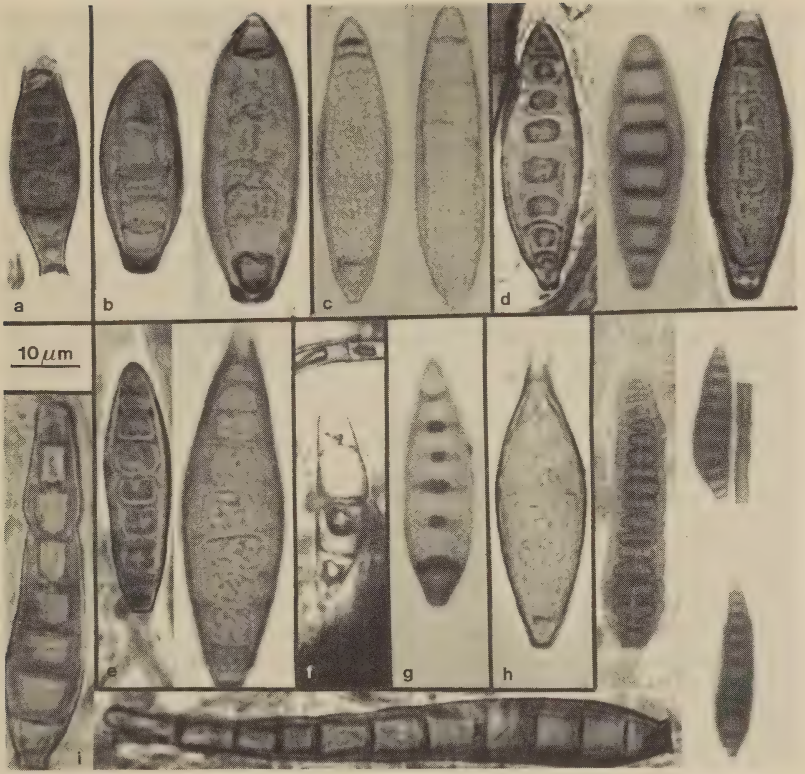


Figure 6. **Conidia of different species: a, *Strossmayeria alnicola,*** HT; **b, *S. atriseda,*** HT; **c, *S. bakeriana,*** left spore *S. longispora,* HT, right spore *S. ostoyae,* HT; **d, *S. basitricha,*** left spore HT, central spore Kew, Twycross 302, right spore *G. pilatii,* HT; **e, *S. introspecta,*** left spore R. P. K. 1709, right spore CUP 59716; **f, *S. jamaicensis,*** HT; **g, *S. josserandii,*** HT; **h, *S. sordida,*** Isolectotype; **i, *S. notabilis,*** left and bottom spore HT, three spores on right CUP-VEN 4336.

Septa in the conidia are eusepta or pseudosepta, and because the difference is very difficult to see, they will all be called septa here. The septal number varies among species and is thus a useful taxonomic character (Fig. 6). For example, the conidia of *S. japonica* have 3-6 septa, those of *S. jamaicensis* 5, those of *S. alnicola* 5-7, and those of other species 7-11.

Germination of conidia (Fig. 5b-d) begins frequently from the apical cell, as an enlargement of the "bleb", when this is present, or of the apical portion of the cell. Other cells of the conidium are also frequently seen germinating by a phenomenon called here "internal germination." This consists of the growth of a germ tube inside the conidium, arising from one of the cells and growing toward the apex or base alongside the lumen of the adjacent cell or cells until it reaches a break in the conidial wall. It is frequently seen still inside the spore (Fig. 5c, arrow). The conidiophore has also been seen producing hyphae from one of the extremes of the conidiophore.

This monograph makes no attempt to delimit the form species that are the anamorphs of *Strossmayeria* species. The type species of *Pseudospiropes, P. nodosus* (Wallr.) Ellis, has as its teleomorph *S. atriseda* (Saut.) Iturriaga, characterized by grossly protruding scars on the conidiophore, and wide basal scars on the conidium. This is the first report of the teleomorph of that species. A similar species of *Pseudospiropes* occurs as the anamorph of *S. dickorfii* Iturriaga. We have termed such species as having a "*P. nodosus* type" of conidiophore. Species with conidiophores with less protruding scars and usually narrower basal scars on conidia are referable to the *P. simplex* (Kunze) Ellis complex, a group unresolved taxonomically as yet. We have referred to such species as having a "*P. simplex* type" of conidiophore. A major authority on the species in this genus, Dr. S. J. Hughes, has identified as *P. simplex* material in which we have found teleomorph specimens referable in some cases to *S. bakeriana* and in other cases to *S. basitricha*. We list a full synonymy of *P. simplex* only under *S. basitricha,* referring under *S. bakeriana* to that synonymy. The only other species of *Pseudospiropes* that we feel confident of identifying at this point is the anamorph of *S. josserandii* (Grelet) Bertault, which is characterized by the torus at the conidial septa mentioned above, *P. josserandii* (Bertault) Iturriaga. One species of *Pseudospiropes, P. longipilus* (Corda) Hol.-Jech., is said to be the anamorph of a pyrenomycete, *Moriola descensa* Norman (Eriksson, 1981) [= *Melanomma subdispersum* (Karst.) Nerl. & Vogl. (Ellis, 1976)]; we seriously doubt any close relationship of this *Pseudospiropes* to the species we have studied, and believe that *Pseudospiropes* needs redefinition to exclude such species. Many other species of *Pseudospiropes* have been described in recent literature, and a monographic study of this genus is clearly necessary to delimit species. The generic name should surely be held for those species which produce a *Strossmayeria* teleomorph.

TAXONOMY OF *STROSSMAYERIA*

1. GENERIC DIAGNOSIS OF *STROSSMAYERIA (Status Teleomorphosis)*

STROSSMAYERIA Schulzer von Müggenburg, *Oesterr. Bot. Z.* **31:** 313. 1881, emend. Iturriaga, *Mycotaxon* **20:** 172-173. 1984.
Holotype: *Peziza heterosperma* Schulzer, *Oesterr. Bot. Z.* **28:** 320. 1878, (≡ *Strossmayeria rackii* Schulzer, *Oesterr. Bot. Z.* **31:** 313. 1881, a superfluous name based on the same type specimen).

= *Leptobelonium* Höhn., *Sitzungsber. Kaiserl. Akad. Wiss. Wien, Math.-Naturwiss. Kl.*, Abt. 1, **132:** 112. 1923.

Holotype: *Peziza 'helminthicola* Bloxam *in* Höhn.' (= *Belonidium basitrichum* Sacc.).

Apothecia superficial, sessile or with a short point of attachment, generally smaller, but up to slightly more than 1 mm in diameter, turbinate or discoid, exuding a yellow substance in 2-10% aqueous KOH. Receptacle surface smooth, white, whitish, yellow, light brown, grayish, brown, or black, darker toward the base. Disc concolorous with, or paler than upper receptacle, disc smooth, pruinose or slightly granulose. Hymenium hyaline. Ectal excipulum of textura oblita with glassy walls, composed of thin parallel hyphae 1.5-3.0 µm wide, axes of cells parallel to outer surface, cells concolorous with receptacle in its outermost layers, and hyaline in its inner layers, usually all J+ (amyloid blue reaction to Melzer's reagent) with or without pretreatment in 2-10% aqueous KOH. Base of the excipulum composed of rounded to irregular or elongated dematiaceous cells. Medullary excipulum and subhymenium almost indistinguishable from ectal excipulum. Paraphyses long and slender, with swollen tips, hyaline, simple or divided, with or without septa. Asci 8-spored, occasionally 6-spored, clavate or saccate, hyaline when mature, but frequently with brownish to brown dextrinoid contents when young, thick-walled, unitunicate, arising from croziers. Ascospores cylindrical-clavate or subfusoid, from 3- to 7-septate, rarely more than that, cells uniform or enlarged, with or without refractocells and/or disintegrating cells, biseriate to usually multiseriate, J+, generally hyaline, rarely yellow-brown, surrounded by a gel layer which may be thin or thick, smooth or verrucose. Saprophytes on wood, woody portions of fruits, or rarely large grasses or bamboos. Anamorph generally present and always referable to the genus *Pseudospiropes* Ellis.

Etymology: Named for Bishop Strossmayer.

2. GENERIC DIAGNOSIS OF *PSEUDOSPIROPES (Status Anamorphosis)*

PSEUDOSPIROPES Ellis, *Dematiaceous Hyphomycetes,* p. 258. 1971.

Holotype: *Helminthosporium nodosum* Wallr.

Conidiophore macronematous, mononematous, arising from a mass of rounded or elongated brown cells, simple, slightly flexuous or flexuous, thick-walled, septate, brown, lighter toward the apex. Conidiophore base slightly swollen to swollen. Conidiogenous cells polyblastic, integrated, terminal or intercalary, sympodial, cylindrical, flexuous, bearing protruding, cicatrized scars, lighter than the rest of the conidiophore. Conidia solitary, dry, acropleurogenous, simple, fusiform, fusiform with one flat side, or obclavate, truncate at the base, tapering toward the apex, dematiaceous, 3-11-septate or pseudoseptate.

Etymology: From the Greek, *pseudo-*, false, plus the generic name *Spiropes* Cifferi.

3. KEY TO THE SPECIES OF *STROSSMAYERIA*

1. Apothecial receptacle pure white, cream-colored, yellowish, pale brown or light gray when rehydrated 2
1'. Apothecial receptacle brown to black when rehydrated 14
    2. Apothecia discoid at maturity; ascospores (32-) 35-55 × 3.5-5.1 (-6.6) µm, 6-7-septate, with smooth gel sheath 1.0-1.5 µm wide; conidia with a "torus" around each septal pore, basal cell dark and apical beak usually present . . . . **12.** *S. josserandii*
    2'. Apothecia turbinate when mature; conidia without those characters 3
3. Asci predominantly clavate 4
3'. Asci predominantly saccate 12
    4. Septa and cell walls of mature ascospores yellow-brown. . . . . **15.** *S. ochrospora*
    4'. Septa and cell walls of ascospores remaining hyaline 5
5. Ascospore gel sheath thick or thin, usually smooth; if verrucose, less than 1.5 µm thick 6
5'. Ascospore gel sheath always verrucose and over 1.5 µm thick 11
    6. Ascospores with a smooth gel, with refractocells when mature. . . . . **16.** *S. sordida*
    6'. Ascospores with a thin, smooth or verrucose gel and without refractocells 7
7. Ascospores predominantly 3-4-septate 8
7'. Ascospores predominantly 5-7-septate 9
    8. Ascospores mostly 3-septate, with a thin, smooth to verrucose gel sheath; asci 99-135 × 11-15 µm; conidia 29-41 × 7.0-12 µm, basal scar 2.2 (-2.9) µm wide . . . . **9.** *S. introspecta*
    8'. Ascospores mostly 4-septate, with a thin, verrucose gel sheath; asci 88-107 × 9.0-13 µm; conidia 23-37 × 7.0-10 µm, basal scar 1.0-2.2 µm wide . . . . **8.** *S. immarginata*
9. Ascospores (30-) 37-49 (-64) µm long . . . . **4.** *S. bakeriana*
9'. Ascospores 26-43 (-48) µm long 10
    10. Asci 82-114 × 11-19 µm; conidial width (10-) 11-15 (-17) µm; conidia 6-7 (-8)-septate . . . . **1.** *S. alba*
    10'. Asci (82-) 101-137 (-140) × (9.3-) 11-16 (-19) µm; conidial width 7.0-15 µm; conidia 5-11-septate . . . . **5.** *S. basitricha*

11. Ascospores cylindrical-clavate, with refractocells present or not, but when present not enlarged, disintegrating cells present or not; ascospores 2.9-4.4 (-5.8) µm wide . . . . **6.** *S. confluens*

11'. Ascospores cylindrical, with enlarged refractocells present, disintegrating cells absent; ascospores 4.4-8.0 (-9.3) µm wide. . . . . **10.** *S. jamaicensis*

12. Ascospores long, (31-) 49-64 (-77) µm, frequently with disintegrating cells . . . . **14.** *S. notabilis*

12'. Ascospores usually under 47 µm long 13

13. Asci (84-) 112-142 (-153) µm long; ascospores (29-) 34-40 (-60) × (3.7-) 4.4-5.1 (-7.3) µm, 3-7-septate; conidia fusiform with one flat side, with hyaline apical cell; conidial basal scar broad, (3.7-) 4.4-6.0 (-6.6) µm wide; conidiophore with grossly protruding scars of the *Pseudospiropes nodosus* type . . . . **7.** *S. dickorfii*

13'. Asci 86-108 µm long; ascospores (31-) 37-47 (-50) × 3.7 (-4.4) µm, 6-7-septate; conidia fusiform, all cells brown; conidial basal scar narrow, (1.5-) 2.2-2.9 (-3.7) µm wide; conidiophore with scars that do not protrude grossly . . . . **2.** *S. alnicola*

14. Apothecia discoid with an involute striate margin, receptacle black to dark brown; ectal excipulum of textura porrecta, ascospores (26-) 29-36 × 3.7 (-4.4) µm, regularly 7-septate. . . . . **13.** *S. nigra*

14'. Apothecia turbinate, with a straight and smooth margin, receptacle brown; ectal excipulum of textura oblita 15

15. Ascospores subfusoid to slightly clavate, (26-) 29-37 × (3.7-) 4.4-7.3 µm, usually 4-5-septate; conidiophore tortuous with grossly protruding scars of the *P. nodosus* type; conidia fusiform. . . . . **3.** *S. atriseda*

15'. Ascospores cylindrical-clavate, (34-) 37-45 × 3.7-4.4 µm, 7-septate; conidiophore straight, with only slightly protruding scars of the *P. simplex* type; conidia obclavate to fusiform . . . . **11.** *S. japonica*

4. DISTRIBUTION OF KNOWN SPECIES OF STROSSMAYERIA

Not much can be said about the distribution of species of *Strossmayeria* because they have seldom been collected due to their exceptionally small size and the lack of interest by pathologists in their being potential pathogens. They are thus typically overlooked by the general collector. A few workers have collected the rather obvious hyphomycetous anamorph, often without being aware that they had also collected the teleomorph. A map is provided (Fig. 7) of the known distributions, which clearly reflects the lack of collections from very large areas of the world. When such areas have been explored by mycologists intent on finding such minute fungi, the distribution picture will doubtless be greatly different.

5. DESCRIPTION OF ACCEPTED SPECIES OF *STROSSMAYERIA*

1. ***Strossmayeria alba*** (Crouan & Crouan) Iturriaga & Korf, *comb. nov.* (Fig. 2a, 4a, 8).
≡ *Lecanidion album* Cr. & Cr., *Florule du Finistère,* p. 45. 1867. (!!)
≡ *Belonidium album* (Cr. & Cr.) Sacc., *Syll. Fung.* **8:** 498. 1889.

Anamorph: *Pseudospiropes* sp.

Apothecium turbinate, sessile with a small point of attachment to the substrate, 0.2-1.0 mm in diameter, solitary or gregarious, but never confluent, the entire receptacle white or grayish-white, disc concolorous with receptacle. Ectal excipulum of textura oblita, 56 µm thick in median section, J+, cells pale in the outer ectal excipulum, and hyaline in the inner ectal excipulum, 2.9-3.7 µm wide. Subhymenium of textura intricata. Asci 8-spored, clavate, 82-114 × 11.2-18.7 µm. Ascospores cylindrical-clavate, hyaline, J+, with uniform cells, biseriate to triseriate, 29-43 × (2.9-) 3.7-6.6 µm, (1-) 5-7-septate, gel sheath usually smooth, only slightly verrucose in the holotype, 1.0-1.5 µm thick. Paraphyses long and filiform, simple, septate, with a clavate swelling at the apex, (0.7-) 1.5 (-2.2) µm at the middle, (1.5-) 2.2-2.9 (-3.7) µm at the apex. Conidiophore brown, lighter toward the apex, septate, flexuous, with evident protruding scars, (5.1-) 5.9-8.8 µm wide at the middle, base swollen to 7.3-15 µm wide, wall 0.7-1.5 (-2.2) µm thick. Conidia fusiform, brown, 30-39 × (10-) 11-15 (-17) µm, basal scar width (1.5-) 2.2-4.4 µm, septa 6-7 (-8), usually with the first two septa of each end darker than the rest.

Holotype: *Patellaria alba* Crouan mscr (*Lecanidion*). Sur un *Helminthosporium* sur un tronc du noisetier, couleur blanche à l'état vivant, le 25 Nvbre 1861, CO.

Type locality: Province of Finistère, France.

Habitat: On decorticated wood of *Corylus* and on rotting, decorticated and/or fallen logs of unknown hosts.

Distribution: Canada, France, U.S.A.

Exsiccatae specimens examined: None

Other specimens examined: CANADA: Tarzwell, Ontario (near Kirkland Lake) on fallen log, boreal forest beaver swamp, 6 Sept. 1979, George P. White 563, DAOM 173085a (as *Pseudospiropes simplex*); same data, 6 Sept. 1979, G. P. White 554, DAOM 173089 (as *P. simplex*).

UNITED STATES: Swain County: along Indian Creek, Great Smoky Mountains National Park, on decorticated log, August 14, 1968, C.T. Rogerson, NY, Fungi of North Carolina (as *S. basitricha*).

Illustrations: Fig. 2a, 4a, 8 in this paper.

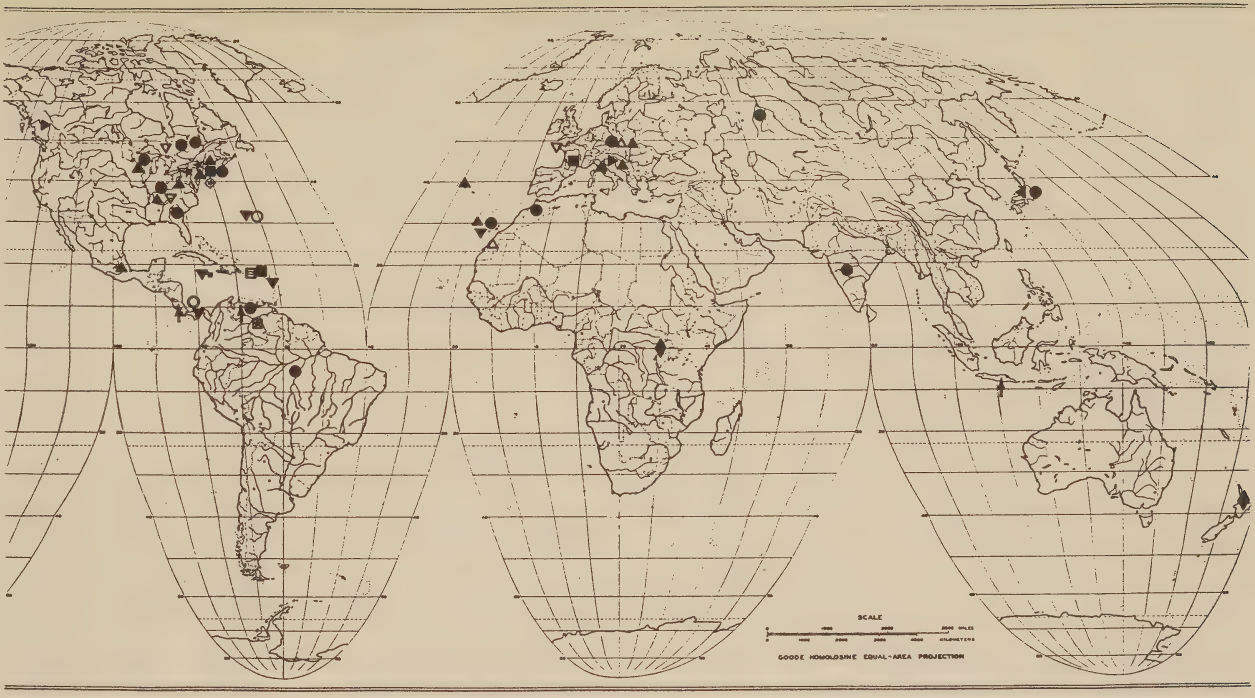

SCALE
GOODE HOMOLOSINE EQUAL-AREA PROJECTION

Figure 7. **World distribution of species of *Strossmayeria*.**

▽ *S. alba* △ *S. alnicola* ▶ *S. atriseda* ● *S. bakeriana* ▲ *S. basitricha* ▼ *S. confluens*
□ *S. dickorfii* ▩ *S. immarginata* ★ *S. introspecta* ▪ *S. jamaicensis* ◀ *S. japonica* ■ *S. josserandii*
◈ *S. nigra* ↑ *S. notabilis* ◆ *S. ochrospora* ○ *S. sordida*

Etymology: The epithet *alba* comes from Latin, white.

Notes: Our observations of the holotype agree totally with the short description of it (*Lecanidion album*) by Crouan & Crouan (1867), except for the 6-septate ascospores they describe. We saw just one 6-septate spore on this HT, the ascospores being mostly 5 or 7-septate. Though there were no drawings accompanying the description, there is a drawing with the specimen of part of an ascus with ascospores, in which Crouan & Crouan drew two 6-septate and two 7-septate ascospores (Fig. 8e).

No details are given on the label of the type specimen, or in the publication, of the collecting locality. Because the specimens at CO may not be loaned, a visit was made by R. P. Korf in 1983 to Concarneau, Province of Finistère, France, to locate the holotype of *L. album*, but unfortunately he was unable to find the specimen amongst the uncatalogued and generally unarranged collection. Because of this, the senior author reported the holotype of *L. album* as lost (Iturriaga, 1984). In 1987 a second trip was made to Concarneau by F. Candoussau, R. P. Korf, T. Iturriaga, and W.-y. Zhuang to try to locate the specimen, and this time we were successful (Korf, et al., 1988). We discovered that in 1979 it had been located and annotated as *S. basitricha* by Steven E. Carpenter, but we do not agree with his taxonomic placement of this specimen, and accept both species as distinct. The Crouan brothers often collected around Brest, and there were (and still are) some small forests of hazelnut in the places where they often collected (information obtained from M. Yves Le Gal, subdirector of the Marine Biological Station at Concarneau). Four mycologists, F. Candoussau, R. P. Korf, T. Iturriaga, and W.-y. Zhuang, tried collecting duplicate material in September 1987 and were unsuccessful. They may have been to the wrong places, or they may have been too early in the season since the type was collected in November (Korf, et al., 1988). The original publication of the Crouans mentions "Aut. r.," meaning that the fungus was collected in the autumn, and is rare.

Morphologically, *S. alba* can be separated from its closest relative, *S. basitricha*, by the pure white apothecia, shorter and broader asci, broader ascospores, broader conidia, wider basal scar of the conidium, and fewer conidial septa. Saccardo (1889) correctly accepted them as different species.

2. ***Strossmayeria alnicola*** (Vel.) Iturriaga, *comb. nov*. (Fig. 4b, 6a, 9).
≡ *Belonium alnicola* Velenovský, *Monogr. Discomyc. Bohem.* **1:** 180. 1934. (!!)

Anamorph: *Pseudospiropes* sp.

Apothecia 0.2 mm in diameter, solitary or gregarious, turbinate, arising from a mass of brown irregular cells that form the point of attachment from which the conidiophores also arise, upper receptacle cream colored, dark brown toward the base, disc concolorous with upper receptacle. Ectal

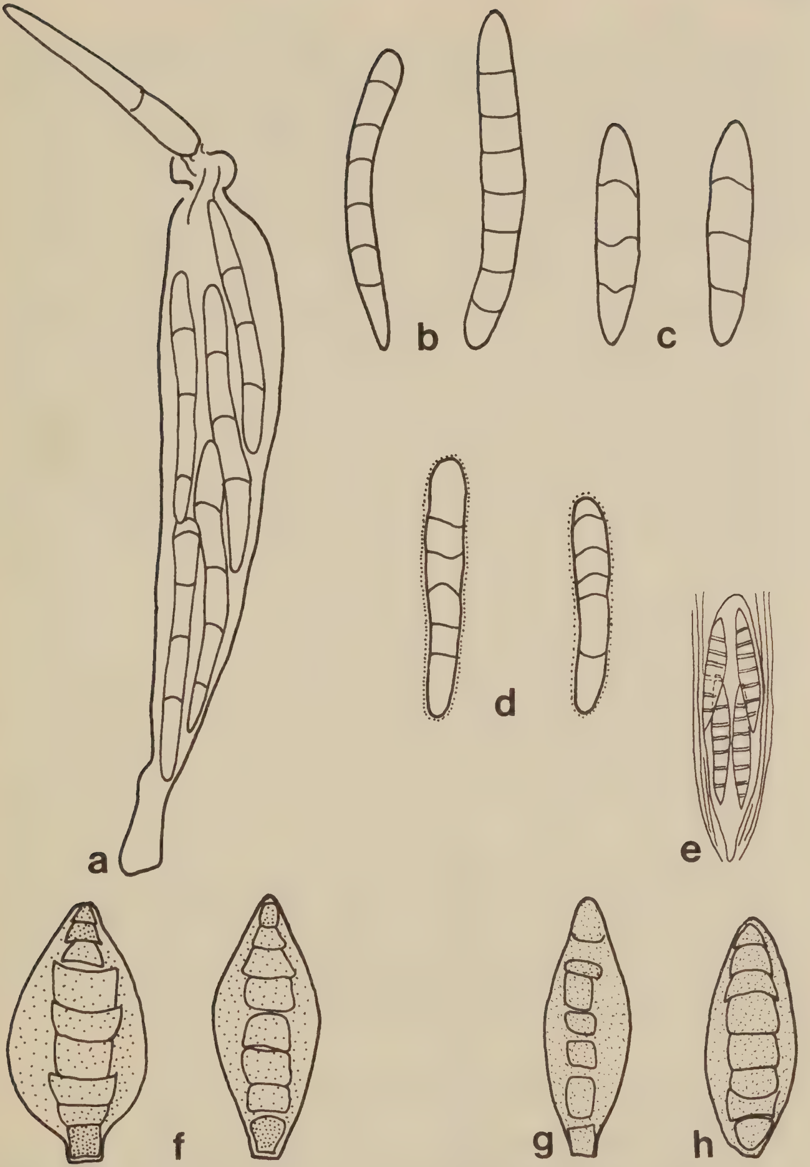


Figure 8. ***Strossmayeria alba.*** **a,** asci with ascospores; **b, c, d,** ascospores; **e,** asci with ascospores and paraphyses, inked copy from Crouan's drawing with HT, magnification unknown; **f, g, h,** conidia. **a, h,** DAOM 173085a; **b, f,** DAOM 173089; **c, d, g,** HT. All except **e** ×1000.

excipulum of textura oblita, 19-21 µm wide in median section, J+, formed mostly by long rectangular cells, basal cells round and brown, elongated and rectangular in the middle, near the margin hyaline and longer, the apical terminal cells with a rounded apex, cells (6.6-) 10-18 × (1.5-) 2.2-2.9 (-3.7) µm. Medullary excipulum and subhymenium not distinguishable. Asci 8-spored, saccate when mature, or at least without an elongated stipe and tapering down to a rounded base, with a short stipe when young, 86-108 × (13-) 15-17 (-19) µm. Ascospores cylindrical-clavate, hyaline, giving a faint J+ reaction, with uniform cells, multiseriate, (31-) 37-47 (–50) × 3.7 (-4.4) µm, (6-) 7-septate, gel sheath smooth and (0.7-) 1.5 µm thick. Paraphyses long and filiform, simple or divided, with a clavate apical swelling, (1.5-) 2.2 µm at the middle, 2.9-3.7 (-4.4) µm at the apex. Conidiophore brown, flexuous, with scars that do not protrude greatly, lighter toward the apex, 6.6-9.5 (-12) µm wide at the middle, base swollen, wall 0.7-1.5 (-2.2) µm wide. Conidia fusiform, brown, (28-) 30-37 (-40) × (8.8-) 11-12 µm, basal scar width (1.5-) 2.2-2.9 (-3.7) µm, 5-8-septate.

Holotype: Flora Bohemica, No. 151014, = *Belonium alnicola* Vel. M.D. 180. 1934, [*Gorgoniceps alnicola* Vel. in herb. et lit.], Mnichovice, *Alnus*, VIII 1926, J. Velenovský, PRM. [Data from description: In trunco udo putrido alnea prope Mnichovice 1926, 8. Inclinat ad genus *Gorgoniceps*, conf. e. gr. *Gorg. sambuci*.]

Type locality: Mnichovice, Czechoslovakia.

Habitat: On rotted trunk of *Alnus*.

Distribution: Only known collection is the HT from Czechoslovakia.

Exsiccatae specimens examined: None.

Other specimens examined: None.

Illustrations: Velenovský, J., *Monogr. Discomyc. Bohem.* **2:** Pl. 4, Fig. 4, 1934; Fig. 4b, 6a, 9 in this paper.

Etymology: The epithet *alnicola* is from Latin, meaning inhabiting *Alnus*.

Notes: Our measurements of ascus and ascospore length are smaller than the ones given by Velenovský (1934).

One distinctive feature of this species is its saccate asci. It can be distinguished from *S. alba* in that the ascospores are longer and thinner and the conidia are narrower, from *S. basitricha* in that ascospores are longer and in that the ascus shape is different and wider, and from *S. bakeriana* in ascus shape, width, and the wider conidial basal scar.

3. ***Strossmayeria atriseda*** (Saut.) Iturriaga, *comb. nov.* (Fig. 3d, 3g, 4c, 6b, 10).

≡ *Peziza atriseda* Saut., *Flora* **28:** 133. 1845. (!!)

≡ *Tapesia atriseda* (Saut.) Poetsch and Schiedermayr, *Syst. Aufz. Krypt.* p. 158. 1872.

Anamorph: *Pseudospiropes nodosus* (Wallr.) Ellis, *Dematiaceous Hyphomycetes* p.258. 1971.

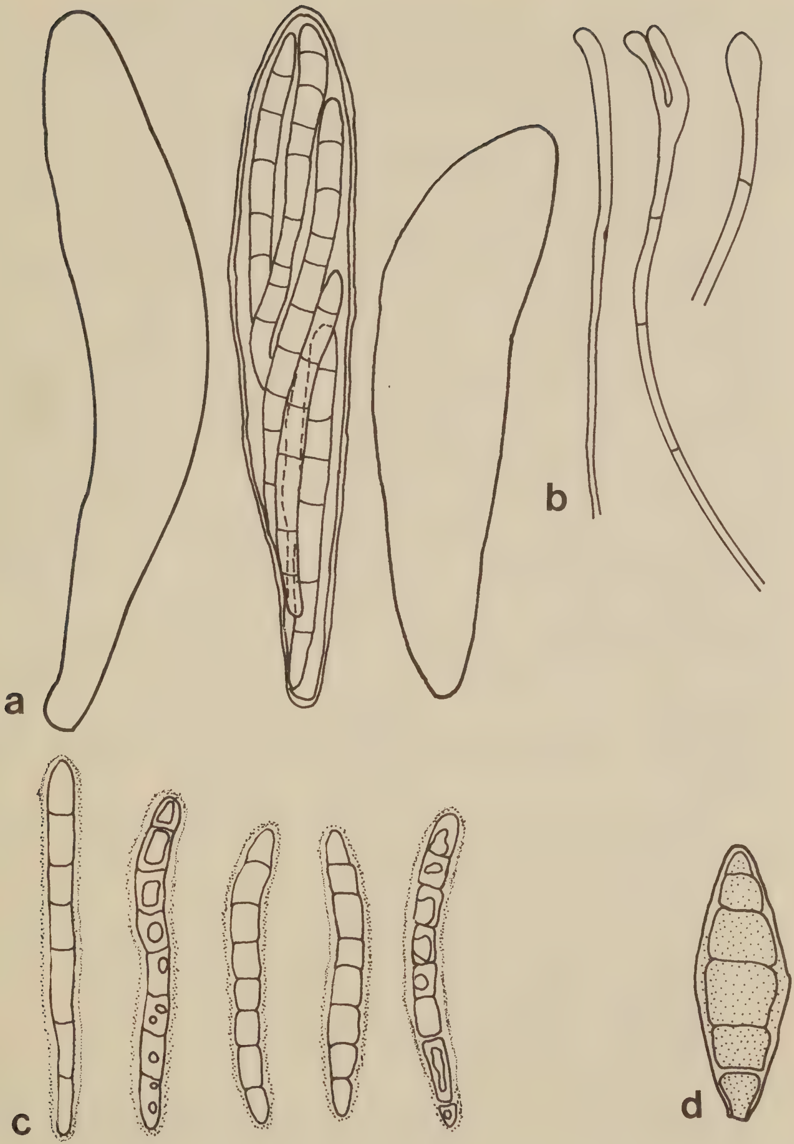


Figure 9. *Strossmayeria alnicola* (HT). **a**, asci, one with ascospores; **b**, paraphyses; **c**, ascospores; **d**, conidia. All ×1000.

Apothecia turbinate, sessile, 0.5 to slightly more than 1 mm in diameter, solitary to gregarious, but growing individually, the entire receptacle brown and glossy, disc concolorous with receptacle, base of the apothecia composed of brown irregular cells, from which also arise conidiophores of *Pseudospiropes*. Ectal excipulum of textura oblita with very glassy walls, 12-16 µm wide in median section, J+ with a strong blue reaction, cells rectangular and elongate, 8.0-14 (-18) × (1.5-) 2.2-2.9 µm, apical cells with rounded apices. Medullary excipulum and subhymenium not evident. Asci 8-spored, clavate with a long stipe tapering down to a fine base, with brown dextrinoid cytoplasmic contents when young, arising from croziers, (122-) 131-150 (-154) × 13-19 µm, apical ascosporogenous region (84-) 91-107 (-112) × 13-17 (-19) µm. Ascospores subfusoid, slightly clavate, hyaline, J+, with uniform cells, generally biseriate but rarely triseriate, (26-) 30-37 × (3.7-) 4.4-7.3 µm, (1-) 4-5 (-7)-septate, gel sheath smooth, 0.7 (-1.5) µm wide. Paraphyses long and filiform, simple or divided, septate, apex slightly swollen in a clavate or irregular shape, exceeding asci by 7.3 µm, 1.5 µm wide at the middle, (1.5-) 2.2 µm wide at the apex. Conidiophore brown, septate, with large scars and a zig-zag shape due to the scars left by the secession of the conidia during sympodial conidiogenesis, (7.3-) 9.5-15 (-18) µm, young conidiophores without scars, straight and thin, 7.3 µm wide, base slightly swollen. Conidiogenous cell terminal, lighter than the rest of the conidiophore, thin-walled with a round apex less than 0.7 µm wide, 21 × 8.8-10 µm. Conidia fusiform, brown, (28-) 33-42 × (10-) 11-13 (-18) µm, basal scar thickened at the edges, (3.7-) 4.4-5.9 (-6.6) µm, septa (3-) 7 (-8), frequently very light and difficult to see, apical and/or basal cells sometimes darker.

Holotype: *Peziza atriseda* Saut., Damberg 8/8, [Damberge bei Steyr, Ober-Osterr., 8 August 1842], Herb. Mus. Palat. Vindob., Acqu. 1917 Nr. 1295, W.

Type locality: Damberg Mt., near Steyr, “upper Austria.”

Habitat: On old moist wood that it covers in a stellate fashion, and on decorticated wood of *Corylus avellana*.

Distribution: Canada, Germany.

Exsiccatae specimens examined: None.

Other specimens examined: CANADA: On *Corylus avellana*, Burnaby South, British Columbia, 13 August 1957, S. Hughes, DAOM 59658 (as *Helminthosporium nodosum* Wallr., det. S. J. Hughes).

Illustrations: Fig. 3d, 3g, 4c, 6b, 10 in this paper.

Etymology: The epithet *atriseda* is from Latin, meaning with a black subiculum.

Notes: Saccardo (1889), and Rehm *in* Rabenhorst (1887-96: 582), accepted the name *Tapesia atriseda*. Saccardo repeated Sauter’s (1845) Latin diagnosis and gave a Latin translation of the collecting data, though he added the size of the apothecia “Cupulae 600 µ. ad 1 mm. latae” which presumably he transcribed from Sauter's description “die Becher 1/4-1/2‴ breit.” Rehm gave Sauter’s and Saccardo’s information in German. Both

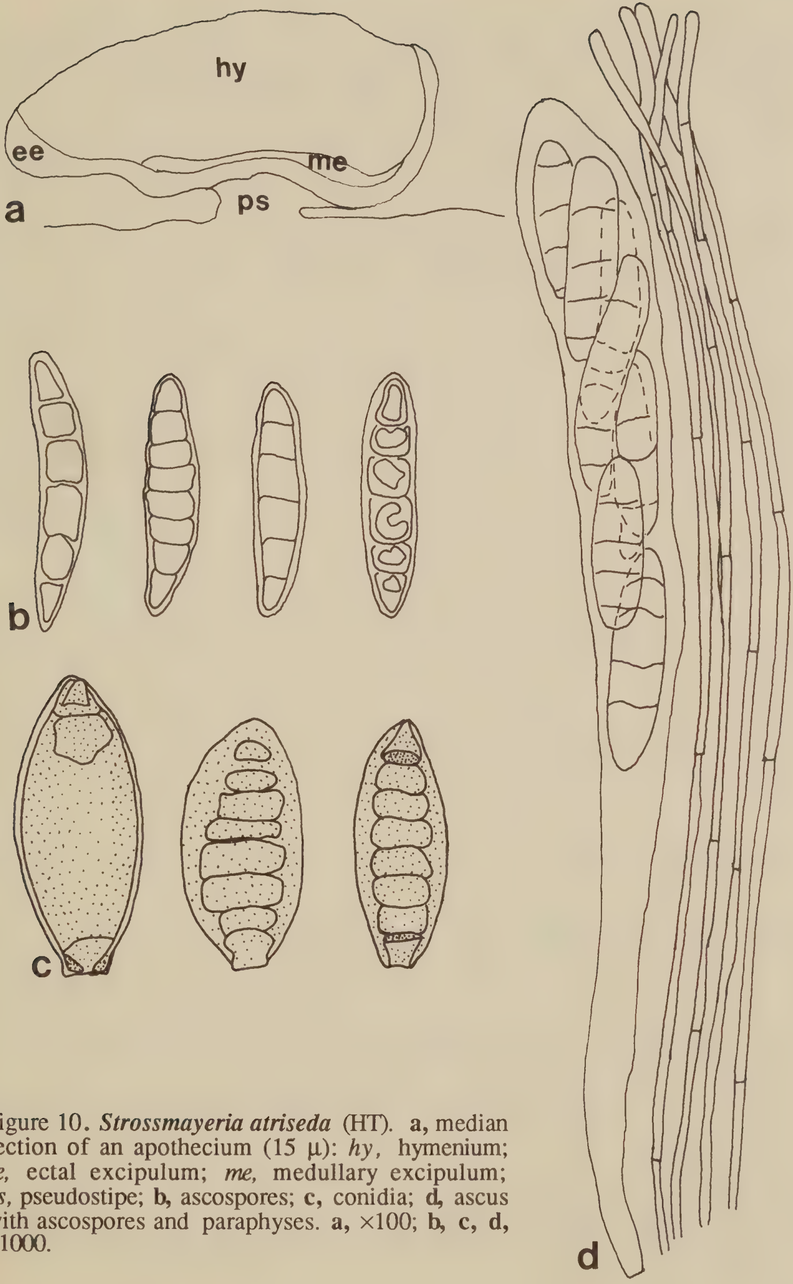


Figure 10. *Strossmayeria atriseda* (HT). **a**, median section of an apothecium (15 μ): *hy*, hymenium; *ee*, ectal excipulum; *me*, medullary excipulum; *ps*, pseudostipe; **b**, ascospores; **c**, conidia; **d**, ascus with ascospores and paraphyses. **a**, ×100; **b**, **c**, **d**, ×1000.

of them followed Poetsch and Schiedermayr (1872) in placing this species in the genus *Tapesia,* probably because of the presence of a subiculum that was described. Poetsch and Schiedermayr assumed the presence of a subiculum from Sauter's description of *P. atriseda* "auf feuchtem, altem Holze ges. das sie stellenweise überzieht" (covering the wood in a stellate manner). Sauter interpreted the conidiophores and mycelium of *Pseudospiropes* as a subiculum. It was Keissler (1917) who examined the type specimen, gave a full description, correctly interpreted the "subiculum" as being a hyphomycetous "*Helminthosporium,*" and so treated the species again in *Peziza* as *P. atriseda*. He stated that this was a synonym of *P. helminthosporii* Blox. in herb. [for which he made a new combination under the genus *Belonium, B. helminthosporii* (Blox.) Keissl.]. In his annotation of the type specimen he noted as a synonym *Belonidium minutissimum* (Batsch) Sacc. For *Belonidium basitrichum* Sacc. he made another combination as *Belonium basitrichum* (Sacc.) Keissl. Though he was incorrect in stating that *P. atriseda* was conspecific with these specimens [he was misled by Saccardo's description of *Belonidium minutissimum* (Batsch) Phillips, *Syll. Fung.* **8:** 504. 1889, which states that the ascospores of Batch's species are 4-septate], he was the first to indicate the existence of a relationship among them, all of which are considered here as members of the genus *Strossmayeria.*

Keissler's description of *P. atriseda* agrees completely with ours.

The specimen DAOM 59658 differs in smaller ascus measurements and in smaller ascospore width than in the HT. The rest of the data match perfectly.

This appears to be the first report of the connection between *Pseudospiropes nodosus* (Wallr.) Ellis and its teleomorph. We agree with Hughes's identification of the anamorph in DAOM 59658, though he overlooked the presence of the teleomorph.

4. ***Strossmayeria bakeriana*** (P. Henn.) Iturriaga, *comb. nov.* (Fig. 2d, 3a, 4d, 5b-d, 6c, 11, 12).

≡ *Hyaloderma bakeriana* P. Henn., *Hedwigia* **48:** 103. 1908. (!!)
= *Gorgoniceps crataegi* Velenovsky, *Monogr. Discomycet. Bohem.* **1:** 182. 1934. (!!)
= *Gorgoniceps sambuci* Velenovsky, *Monogr. Discomycet. Bohem.* **1:** 182. 1934. (!!) (!)
= *Strossmayeria longispora* Raitviir, *Biol. Zh. Armen.* **21**(8): 9. 1968. (!!)
= *Strossmayeria ostoyae* Bertault, *Rev. Mycol. (Paris)* **35:** 140. 1970. (!!)

Anamorph:

? *Pseudospiropes simplex* (Kunze) Ellis and other synonyms listed below under *Strossmayeria basitricha.*
?= *Helminthosporium ostoyae* Bertault, *Rev. Mycol. (Paris)* **35:** 140. 1970. (!!)

Apothecia turbinate, with a small point of attachment, 0.2-1.0 mm in diameter, receptacle light brown to grayish when dry, upper receptacle whitish to yellowish or beige when rehydrated, brown toward and at the base; disc concolorous with upper receptacle, rarely slightly darker, granulose; margin sometimes slightly involute, irregular; exuding yellow substance in 2% aqueous KOH; anamorph arising from the base of the apothecium. Ectal excipulum of textura oblita, 15-37 µm thick, J+, composed of septate parallel hyphae with gelatinized walls, cells of the outer layer brown, cells of the inner layer hyaline, cream colored or light brown, cells sometimes with angular inclusions, upper cells sometimes clavate and longer than the basal ones: (8.0-) 16-22 (-26) × 2.2-3.7 µm, the cells more toward the base (6.6-) 15-19 × 1.5-2.9 (-3.7) µm. Medullary excipulum and subhymenium indistinguishable one from the other, composed of a small amount of textura intricata. Asci clavate, arising from croziers and sometimes also from repeating croziers, (64-) 74-124 (-156) × (9.3-) 10-15 (-20) µm. Ascospores cylindrical-clavate, hyaline, (29-) 37-49 (-64) × (2.9-) 3.6-4.5 (-5.4) µm, (3-) 6-7 (-8)-septate; gel sheath faintly evident, often extremely thin, smooth, (0.7-) 1-2 µm thick. Paraphyses long and filiform, simple or divided, septate, not at all or up to 37 µm longer than the asci, swollen toward the tip, hyaline, 0.7-1.5 (-2.2) µm wide in the middle, (1.5-) 2.2-3.7 µm wide at the apex. Conidiophores macronematous, mononematous, arising from a mass of roundish, elongated, or irregular brown cells, simple, slightly flexuous to flexuous, thick walled, septate, cinnamon-brown, becoming yellowish brown toward the apex, (4.4-) 5.9-8.0 (-9.5) µm wide at the middle, base swollen to 7.3-11 (-15) µm wide. Conidiogenous cell polyblastic, integrated, terminal, or intercalary, sympodial or percurrent, cylindrical, flexuous, bearing protruding scars, lighter in color than the rest of the conidiophore. Conidia solitary, dry, acropleurogenous, simple, fusiform, truncate at the base, tapering toward the rounded apex, concolorous with the darker part of the conidiophore, (22-) 29-44 (-48) × (7.2-) 8.8-16 µm, basal scar width (1.5-) 2.0-3.6 (-4.5) µm, septa (3-) 7-11 (-12), usually with the first septum nearest to the base darker than the remainder and also sometimes one or more of the apical septa darker.

Holotype: In vaginis *Bactridis majoris*. Pará, Hort. botan. Mus. Goeldi, 1. 1908, C. F. Baker, n. 202*a* [in societate *Cyphellae paraensis* in hyphis *Helminthospori*], S.

Type locality: Pará, Brazil.

Habitat: On dry culm of *Acacia macracantha, Acer, Bactris major, Castanea dentata, Castanea* sp., *Crataegus oxyacanthae, Fraxinus americana, Quercus, Rubus fruticosus, Sambucus racemosa, Zelkova,* conifer wood, fallen bamboo fence, decorticated, rotten or wet wood or stumps or branches or twigs of unknown hosts.

Distribution: Brazil, Czechoslovakia, Canada, Canary Islands, India, Japan, Morocco, U. S. S. R., U. S. A., Venezuela.

Exsiccatae specimens examined: CUP 60680, to be issued in Korf & Gruff, Discomycetes Exsiccatae.

Other specimens examined: CANADA: On wood, boreal forest beaver swamp, Tarzwell, Ontario (near Kirkland Lake), 7 Sept. 1979, DAOM 173358 (as *Pseudospiropes simplex* and *Strossmayeria*); Duchesnay, Quebec, Aug. 24, 1938, C. L. Shear 4182-a (as *Belonidium basitrichum*), BPI.

CANARY ISLANDS: **Tenerife:** On wet wood, West of Fuente de las Pulgas, Las Yedras, Monte de Las Mercedes, January 12, 1976, R. P. Korf, W. C. Denison, L. M. Kohn, M. A. Sherwood, CUP-MM 561; On wood, West of Fuente de las Pulgas, Las Yedras, Monte de Las Mercedes, January 12, 1976, R. P. Korf, W. C. Denison, L. M. Kohn, M. A. Sherwood, CUP-MM 562.

CZECHOSLOVAKIA: On *Sambucus racemosa,* Bohemia centralis: Jevany, IX. 1933, J. Velenovský, Flora Bohemica No. 812389 , Akc. no. 29/1947 (as *Gorgoniceps sambuci*, Holotypus), PRM; On *Rubus fruticosus,* Mnichovice: Myrlín (Bohemia centralis), 2. XI. 1933, J. Velenovský, Flora Bohemica, No. 151008, Akc. no. 29/1947 (as *Gorgoniceps sambuci,* Paratypus), PRM; Stráncice (Bohemia centralis). In colle arido ad *Crataegum oxyacanthae*, 3. VIII. 1933. J. Velenovský, No. 151006 (as *Gorgoniceps crataegi,* Holotypus), PRM.

INDIA: On decaying *Quercus* log, Shergron (Arimachal Pradish), Sept. 8, 1981, R. Sharma, PAN 24028, CUP-IN 622.

JAPAN: On plywood, Asegata, Chuzenji-kohan, Okku-Nikko, Tochigi Pref., Honshu, 22. VIII. 1983, IMC_3 workshop people, CUP-JA 3621; On decorticated stump, along inlet creek south of Lake Karikomi, Okku-Nikko, Tochigi Pref., Honshu, 23. VIII. 1983, IMC_3 workshop people, CUP-JA 3648 (cultured by Kohn); On branch, Asegata, Chuzenji-kohan, Okku-Nikko, Tochigi Pref., Honshu, 25. VIII. 1983, IMC_3 workshop people, CUP-JA 3677; On fallen bamboo fence, Asegata, Chuzenji-kohan, Okku-Nikko, Tochigi Pref., Honshu, 25. VIII. 1983, IMC_3 workshop people, CUP-JA 3694; On wood, Kotoku-bokujo, Okku-Nikko, Tochigi Pref., Honshu, 26. VIII. 1983, IMC_3 workshop people, CUP-JA 3697; On a twig, Jujo Seichi Co. forest, Katashima-mura, Tone-gun, Gumma Pref., Honshu, 26. VIII. 1983, IMC_3 people, CUP-JA 3706.

MOROCCO: Sur bois mort d'*Acacia* sp., accompagné de *Helminthosporium ostoyae* Bertault, Parc Donabo, au Jbel Kbir, près Tanger, 5 Mars 1960, Bertault 11791 (ex 6031) (as *Strossmayeria ostoyae,* holotype, also holotype of *H. ostoyae*), MPU.

UNION OF SOVIET SOCIALIST REPUBLICS: On *Zelkova,* Azerbaidzhaniae, dist. Leriki, 20 Km., 13 Oct., 1962, A. Raitviir (as *Strossmayeria longispora,* holotype), TAA 43152.

UNITED STATES: **Georgia:** On wood, wild area, University of Georgia Botanical Garden, Athens, M. S. A. foray, August 25, 1978, J. H. Haines 3341 (as *Strossmayeria basitricha),* NYS. **Massachusetts:** On decorticated wood, and under bark, White Oaks Rd., near North Adams, 16. VIII. 1986, W.-y. Zhuang, CUP 61799; **New York:** On rotten wood, Yates, Sept. 1900, C. E. Fairman, CUP-D 1052 (73-72); On dead wood, Churchville, Sept. 21, 1901, E. J. D[urand], CUP-D 1275 (73-74); On

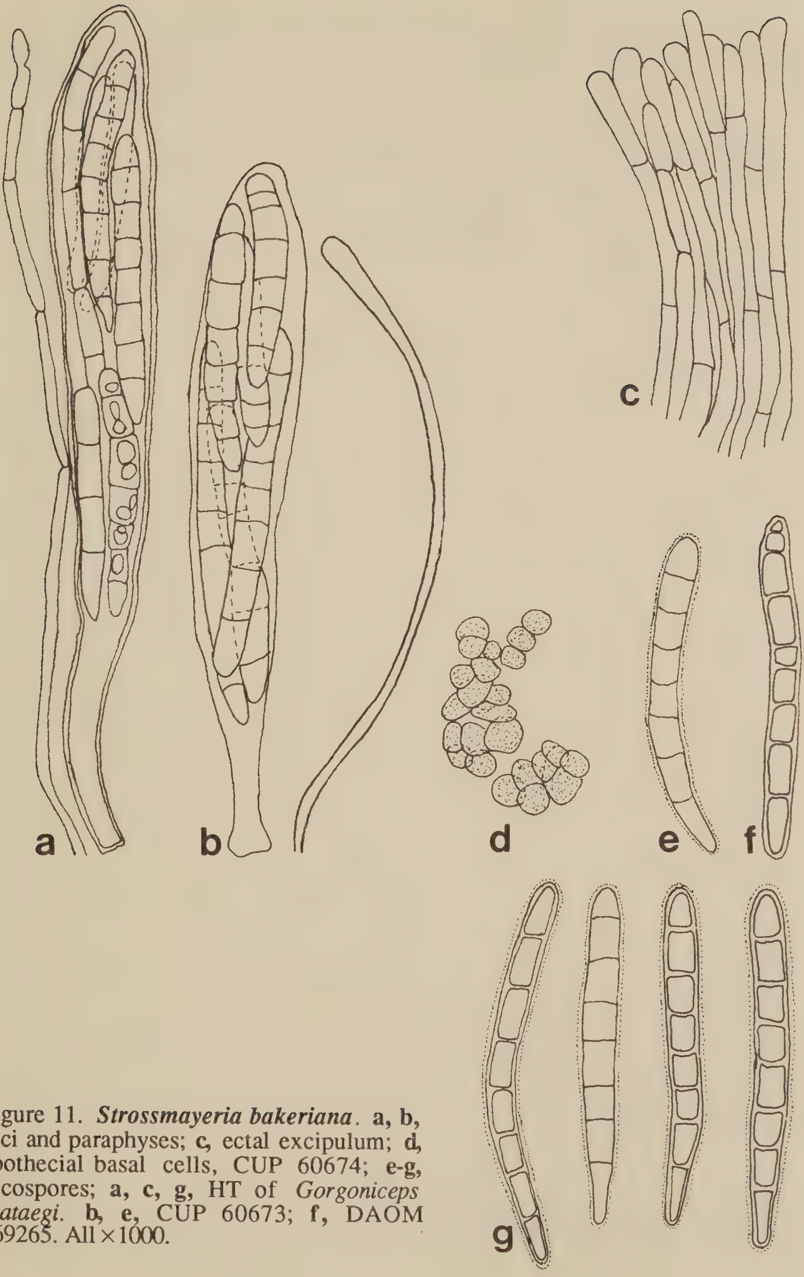
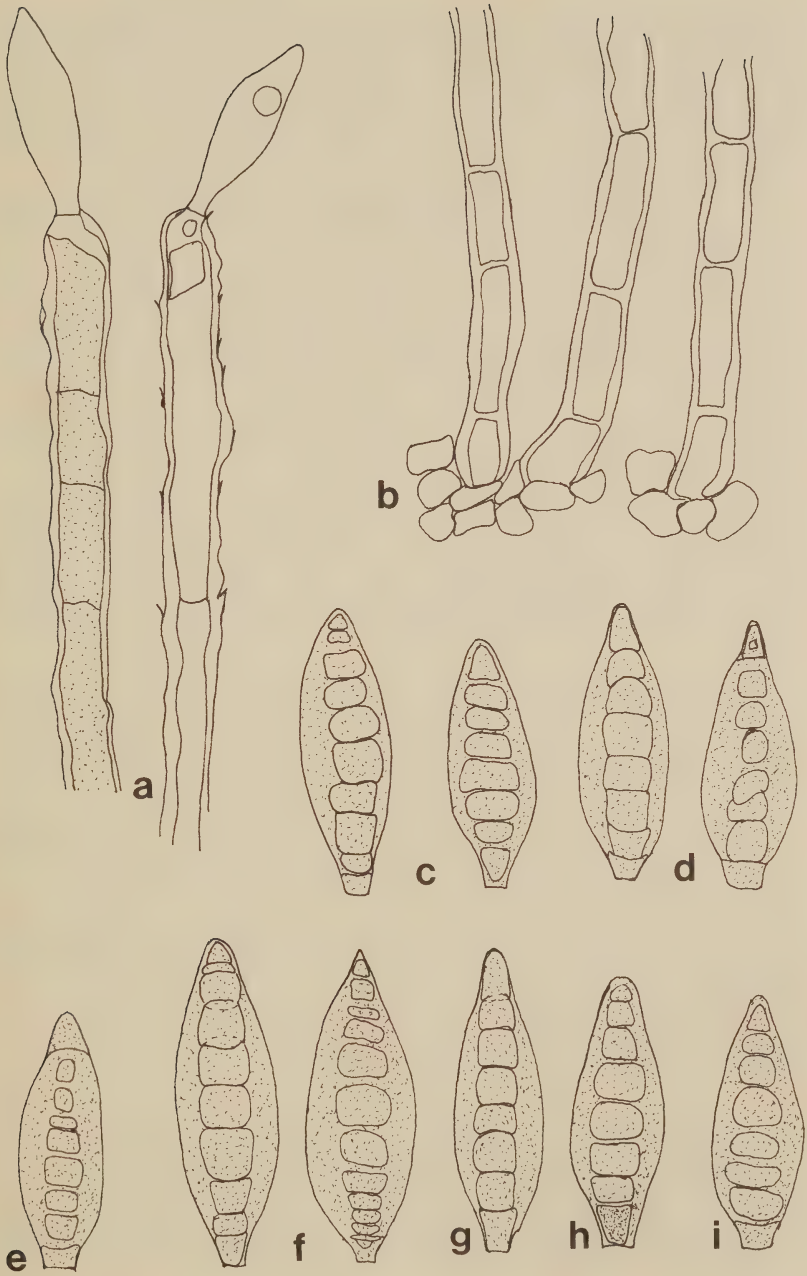


Figure 11. ***Strossmayeria bakeriana***. **a, b,** asci and paraphyses; **c,** ectal excipulum; **d,** apothecial basal cells, CUP 60674; **e-g,** ascospores; **a, c, g,** HT of *Gorgoniceps crataegi*. **b, e,** CUP 60673; **f,** DAOM 169265. All ×1000.

dead stick in damp woods, Churchville, Sept. 21, 1901, E. J. D[urand], CUP-D 1278 (73-73); White Plains, 7. VIII. 1915, F. J. Seaver and P. Wilson, R.P.K. 2025 ex NY (as *Gorgoniceps iowensis*); On *Castanea dentata*, Ringwood, Aug. 29, 1931, C. L. Shear (as *Belonidium basitrichum)*, BPI; On *Castanea* sp., Ringwood, Aug. 29, 1931, C. L. Shear (as *Belonidium basitrichum*), BPI; On wood, Michigan Hollow, 4. IX. 52, S. J. Hughes, DAOM 29173 (as *Helminthosporium simplex* Kunze); On wood, Michigan Hollow, 4. IX. 52, S. J. Hughes, DAOM 29175 (as *Helminthosporium simplex* Kunze); On wood, Lloyd Cornell Preserve, McLean, 5. IX. 1952, S. J. Hughes, DAOM 29179 (as *Helminthosporium simplex* Kunze); On dead wood among a hyphomycete (*Pseudospiropes simplex*), near Bloomingdale, Essex Co., September 11, 1965, D. Malloch, DAOM 136546 (as *Strossmayeria basitricha)* (slide only); Among *Helminthosporium* on wood, 5 Burhans Pl., Delmar, July 11, 1975, J. H. Haines 2817 (as *Strossmayeria basitricha*), NYS; On log of *Quercus*, Peck foray, Cary Arboretum, Millbrook, Dutchess Co., Sept. 6, 1975, J. H. Haines 2882 (as *Strossmayeria basitricha),* NYS; On *Acer* wood, Peck foray, Cary Arboretum, Millbrook, Dutchess Co., Sept. 6, 1975, J. H. Haines 2883 (as *Strossmayeria basitricha*), NYS; Decorticated wood of *Acer* (ascospores producing phialides present), behind Ordway House, Huyck Preserve, Rensselaerville, Albany Co., Oct. 3, 1976, J. H. Haines 3184 (as *Strossmayeria basitricha),* NYS; On wood, Orange County, 1 mile north of circle on Route 6, vic. Raymond Torrey Monument, Harriman State Park, November 6, 1979, Steven E. Carpenter (as *Strossmayeria basitricha*), NY; Decayed wood of *Fraxinus americana,* Tibbits Recreational Area, on NY rt. 7 just West of the VT line, Rensselaer Co., Aug. 29, 1981, J. H. Haines 3524 (as *Strossmayeria basitricha),* NYS; On wood, Varna, Sept. 28, 1982, T. Iturriaga S-2, CUP 59717; On wood, woods along highway 1 mile west of the forest camp, Newcomb, Sept. 12, 1982, T. Iturriaga S-1, CUP 59718; On wood, near waterfall trail at the bridge at west end of Rensselaerville, Sept. 17, 1983, T. Iturriaga S-7, CUP 59894; On rotten wood in swampy area, St. Lawrence County, Cranberry Lake Campground, along trail S from campground around lake, 1500 ft., Sept. 22, 1983, W. R. Buck 9659, NY; Allegany State Park, Sept. 16, 1984, R. P. Korf, CUP 60673, 60674, 60675, 60676, 60677, 60678, 60679, 60680; On decorticated wood, Huntington Camps, Raquette Lake, 6. IX. 1986, W.-y. Zhuang, CUP 61805; On decorticated wood, Adirondacks, 5. IX. 1986, W.-y. Zhuang, CUP 61806; On decorticated wood, Raquette Lake, Adirondacks, 5. IX. 1986, W.-y. Zhuang, CUP 61807. **Pennsylvania:** On dead wood, Heart's Content, Alleghany Nat'l. Forest, 18. X. 1975, M. A. Sherwood 2120, CUP 54714. **Tennessee:** On bark of fallen branch, Bote Mt., Gt. Smoky

Figure 12. ***Strossmayeria bakeriana.*** **a,** conidiophores with conidia, break of the external wall where other conidia broke off; **b,** base of conidiophores; **c-i,** conidia. **a, b, d, e,** CUP 60677; **c,** HT of *G. crataegi;* **f,** DAOM 51651; **g,** PT of *Gorgoniceps crataegi*; **h,** CUP-IN 622; **i,** CUP 60676. All ×1000.


a
b
c
d
e
f
g
h
i

Mountain National Park, Blount Co., Aug. 23, 1977, S. J. Hughes, DAOM 169265 (as *Pseudospiropes simplex)*; On conifer wood, 1/2 mi. E. of Crib Gap, Blount Co., Great Smoky Mountains National Park, Hesler Symposium at The University of Tennessee, 11. VIII. 1968, J. H. Haines 1769 (as *Strossmayeria basitricha),* NYS. **Wisconsin:** Devil's L., near Madison, IX. 4. 53, D. P. Rogers (as *Strossmayeria* sp., = *Gorgoniceps confluens*), NY, R.P.K. 2777.

VENEZUELA: Sobre cara podada de rama de cují, *Acacia macracantha,* Charallave, Estado Miranda, Junio 1986, T. Iturriaga 680, CUP 61935.

Illustrations: Velenovský, J., *Monogr. Discomycet. Bohem.* **2:** Taf. V, 40. 1934 (*Gorgoniceps crataegi);* Raitviir, A., *Biol. Zh. Armen.* **21**(8): 5, Fig. 4. 1968 (*Strossmayeria longispora);* Bertault, R., *Rev. Mycol. (Paris)* **35:** 139, Fig. 2. 1970; this paper, Fig. 2d, 3a, 4d, 5b-d, 6c, 11, 12.

Etymology: The epithet *bakeriana* is in honor of C. F. Baker, the collector.

Notes: *S. bakeriana* may be distinguished from *S. basitricha* in that it has longer ascospores and wider asci.

The original publication of *Hyaloderma bakeriana* was in Hedwigia, (Hennings, 1908), and was later reprinted (Hennings, 1909). It was misidentified as a pyrenomycete. The HT from S is in poor condition, and though identification was possible by use of the teleomorph, no conidia of the anamorph were seen. According to Rossman (1987), another part of the type collection at FH contained no ascocarps resembling a *Hyaloderma*.

The HT of *G. sambuci* did not have any conidia present of the anamorphic state, *Pseudospiropes,* and its paratype did not have any apothecia present, just the anamorph. The HT of *G. crataegi* has both states present in it. All our measurements of ascospore lengths and some of widths are smaller than Velenovský's measurements, but we agree with his data in the sense that he reported longer ascospores for *G. crataegi* and shorter for *G. sambuci;* though our values differ from his, the proportion between the two is the same.

Our measurements agree totally with Raitviir's (1968) measurements of *S. longispora* for all structures.

In some cases the ascospores were seen to be producing phialides: BPI-August 29, 1931, CUP-JA 3697, CUP-JA 3694, J.H.H. 2882, NYS, J.H.H. 2883, NYS (paraphyses also producing phialides).

Disintegrating cells are present in the ascospores of CUP-JA 3697, CUP-JA 3648, CUP-JA 3677, J.H.H. 3524, NYS.

5. *STROSSMAYERIA BASITRICHA* (Sacc.) Dennis, *British Cup Fungi and their Allies,* p. 73. 1960. (Fig. 2e, 5a, 6d, 13, 14, 15).

≡ *Belonidium basitrichum* Sacc., *Atti Soc. Venet.-Trent. Sci. Nat. Padova* **4:** 135. 1875. (!!)

≡ [*Belonidium helminthosporii* Sacc. *in sched.,* Herb. PAD]

≡ *Arachnopeziza basitricha* (Sacc.) Boud., *Hist. classific. discomyc. Europe*, p. 126. 1907.

≡ *Belonioscypha basitricha* (Sacc.) v. Höhn., *Sitzungsber. Kaiserl. Akad. Wiss., Math.-Naturwiss. Kl., Abt. 1*, **118:** 386. 1909.

≡ *Belonium basitrichum* (Sacc.) Keissl., *Ann. K. K. Naturhist. Hofmus.* **31:** 88. 1917.

≡ *Strossmayeria brevitricha* (Sacc.) Dennis ex Raitviir, *Biol. Zh. Armenii* **21**(8): 9. 1968 (lapsus calami).

= *Peziza heterosperma* Schulzer, *Oest. Bot. Zeitsch.* **28:** 320. 1878. (!!)

≡ *Belonidium heterospermum* (Schulzer) Sacc. & Trott., *Syll. Fung.* **22:** 694. 1913.

≡ *Strossmayeria rackii* Schulzer, *Oest. Bot. Zeitsch.* **31:** 313-315. 1881 (superfluous epithet, based on the same type specimen).

= *Belonidium marchalianum* Sacc., Bomm., & Rouss. *in* Bomm. & Rouss., *Bull. Soc. Roy. Bot. Belg.* **25:** 167. 1886 (!!)

≡ *Belonidium marchandianum* Sacc., Bomm., & Rouss., *in* v. Höhn., *Akad. Wiss. Wien, Math.-Naturwiss. Kl., Abt. 1*, **132:** 112. 1923 (*'Marchandianum'*) (lapsus calami).

?= *Belonidium fructigenum* P. Henn. *in* Warburg, *Monsunia* **1:** 31.1900 (fide v. Höhnel, 1923).

?= *Belonidium albo-cereum* Penz. et Sacc., *Malpighia* **15:** 215. 1902 ('1901').

= [*Peziza helminthosporii* Blox. *in sched.*, Herb. K] ('!!')

≡ [*Belonium helminthosporii* (Blox. *in sched.*) Keissl., *Ann. K. K. Naturhist. Hofmus.* **31:** 88. 1917.]

≡ [*Peziza helminthicola* Blox. *in* v. Höhn., *Sitzungsber. Kaiserl. Akad. Wiss., Math.-Naturwiss. Kl., Abt. 1*, **118:** 884. 1909, lapsus calami].

≡ [*Belonioscypha helminthicola* (Blox. *in* v. Höhn.) v. Höhn. *Sitzungsber. Kaiserl. Akad. Wiss., Math.-Naturwiss. Kl., Abt. 1*, **118:** 885. 1909.]

≡ [*Leptobelonium helminthicola* (Blox *in* v. Höhn.) v. Höhn. *Akad. Wiss. Wien, Math.-Naturwiss. Kl., Abt. 1*, **132:** 112. 1923.]

= *Gorgoniceps iowensis* Rehm, *Ann. Mycol.* **4:** 338. 1906 (*'jowensis'*) (!!)

= *Gorgoniceps pilatii* Vel., *Monogr. Discomycet. Bohem.* **1:** 182. 1934 (*'Pilati'*) (!!)

Misapplications:

Peziza minutissima Batsch, *Elenchus fungorum* **1:** 205, Fig. 143, Tab. 27 & p. 207 (fig. expl.), 1786, by Berk. & Br., *Ann.. Mag. Nat. Hist.*, Ser. 3, **15:** 446. 1865 (fide v. Höhnel, 1909).

Belonidium minutissimum (Batsch) Phillips, by: Phillips, *British Discomycetes*, p. 149. 1887; by Saccardo, Syll. Fung. **8:** 504. 1889; by Schroeter *in* Cohn, *Krypt. -Fl. Schlesien* 3(2): 110. 1893, (fide v. Höhn., *Sitzungsber. Kaiserl. Akad. Wiss., Math.-Naturwiss. Kl., Abt. 1*, **118:** 385. 1909); by Rehm *in* Rabenhorst, Krypt.-Fl. Deutschl., ed. 2, **1**(3): 1228.

1896, (fide Iturriaga); by Massee, *British Fungus Flora* **4:** 224. 1895 (duplication of Phillips's description).

Anamorph: (For additional synonymy, see Hughes, 1958, Ellis 1971.)
Pseudospiropes simplex (Kunze) Ellis, *Dematiaceous Hyphomycetes* p. 260. 1971.
≡ *Helmisporium simplex* Kunze *in* Nees & Nees, *Nova Acta Phys.–Med. Acad. Caes. Leop.-Carol. Nat. Cur.* **9:** 241. 1818.
= *Helmisporium cylindricum* Wallr., *Fl. crypt. Germ.* **2:** 164. 1833.
≡ *Pleurophragmium cylindricum* (Wallr.) Hughes, *Canad. J. Bot.* **36:** 797. 1958.
= *Helminthosporium fusisporium* Berk. *in* Smith, J. E., *Engl. fl.* **5**(2): 336. 1836.
?= *Helminthosporium apiculatum* Corda, *Icon. fung.* **1:** 13. 1837.
= *Helminthosporium fusiforme* Corda, *Icon. fung.* **1:** 13. 1837.
≡ *Arthrinium fusiforme* (Corda) Bon., *Handb. Mykol.* 84. 1851.
?= *Helminthosporium gongrotrichum* Corda, *Icon. fung.* **1:** 13. 1837.
≡ *Helminthosporium gonyotrichum* Corda *in* Schulzer, *Oest. Bot. Zeitsch.* **28:** 320. 1878 (lapsus calami).
= *Helminthosporium belonidium* Sacc., *Fung. ital.* pl. 113. 1877.

Apothecia turbinate, seldom discoid, sessile or pseudostipitate, 0.2-0.8 mm. in diameter, solitary, gregarious or confluent (losing their individuality), receptacle white, cream-colored, yellow, light brown or light gray when rehydrated, receptacle light brown toward the base and brown to dark brown at the base, beige to light brown or yellowish brown when dry; exuding a yellow substance in 2-10% aqueous KOH; disc concolorous with upper receptacle or lighter, white, pallid, light brown, brown, smooth to slightly granulose. Ectal excipulum of textura oblita, composed of rectangularly elongated cells, apical cells with rounded apices, J+, outer ectal excipulum with hyaline cells except in the area from the middle to the base that is composed of brown cells, cells 4.4-18 × 2.2-2.9 (-4.4) µm. Medullary excipulum and subhymenium indistinguishable. Pseudostipe when present composed of textura oblita as a continuation of the ectal excipulum but with broader cells and thicker glassy walls, with a very small amount of textura intricata in the middle. Asci clavate, arising from croziers, (82-) 101-137 (-140) × (9.3-) 11-16 (-19) µm, young asci frequently with dextrinoid contents. Ascospores cylindrical-clavate, sometimes with a not very even outline, hyaline, J+, with uniform cells, biseriate to triseriate, 26-40 (-48) × 2.9-5.1 (-5.9) µm, (3-) 6-7 (-8)-septate, gel sheath generally smooth, 1.0 (-1.5) µm wide, rarely verrucose but never over 1.5 µm wide, rarely not evident; germinating inside and outside the ascus. Paraphyses long and filiform, simple or divided, septate or aseptate, with a slight clavate swelling at the apex, approximately 6.0-10 µm longer than the asci, 0.7-2.2 µm wide at the middle, 2.2-3.7 µm wide at the apex. Conidiophores erect, macronematous, mononematous, arising from a mass of round and irregular brown cells, brown, septate, flexuous,

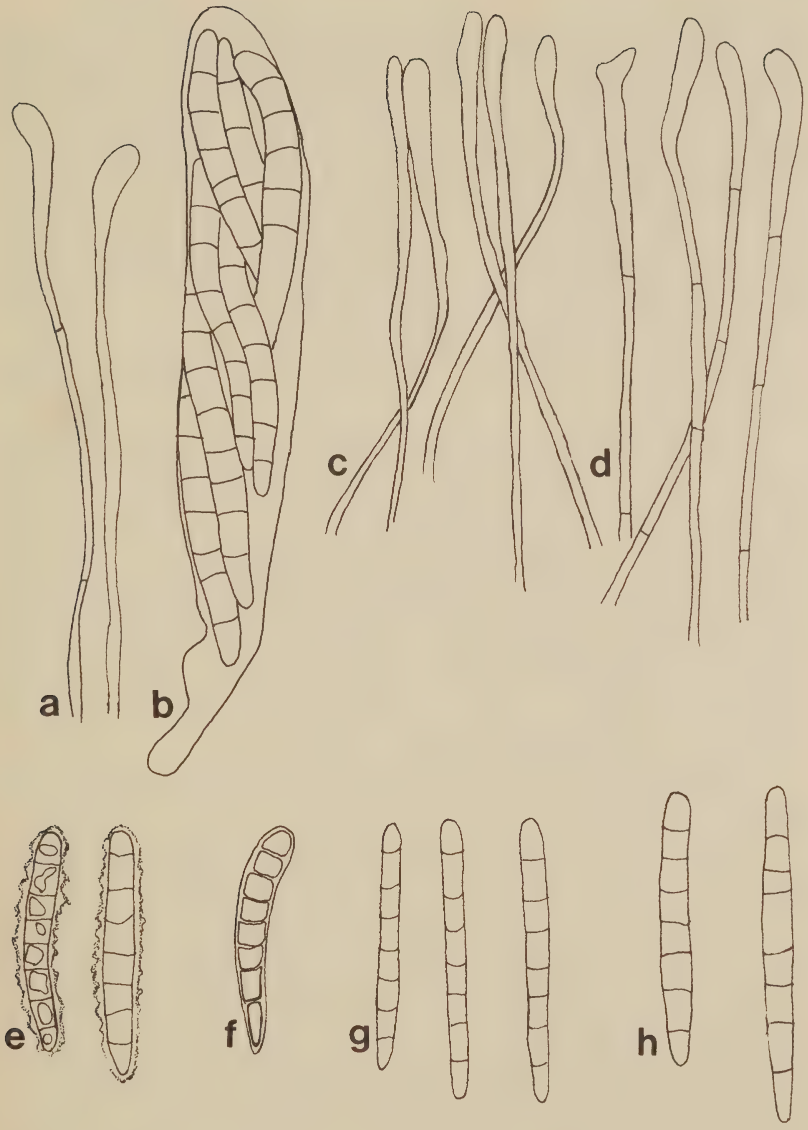


Figure 13. ***Strossmayeria basitricha.*** **a,** paraphyses; **b,** ascus with ascospores; **c, d,** paraphyses; **e-h,** ascospores. **a, g,** Durand 1011; **b, c, h**, NT of *Peziza heterosperma;* **d, f,** HT of *Gorgoniceps pilatii;* **e,** HT of *G. iowensis.* All ×1000.

with evident protruding scars, lighter toward the apex, (3.7-) 5.1-9.3 (-10) µm wide at the middle, base swollen to 5.9-11 µm wide, wall 0.7-1.5 µm thick. Conidiogenous cell polyblastic, integrated, terminal, sympodial, and percurrent, cylindrical-flexuous, bearing protruding scars, lighter than the rest of the conidiophore, light brown, (19) 24-37 × 5.6-7.5 µm. Conidia broadly fusiform, truncate at the base and tapering toward the apex which is rounded and sometimes has an apical bleb, outer wall punctate, dematiaceous, usually with a pedicel-like basal cell, frequently with basal and apical cells darker than the rest, 29-41 (-71) × (6.6-) 7.3-15 µm, basal scar (1.5-) 2.2-3.7 µm wide, (3-) 5-11-septate or pseudoseptate, very commonly 7-septate. Basal and apical dark septa and/or cells sometimes present. Internal germination within the conidia seen.

Holotype: *Belonidium helminthosporii* Sacc., certe aff. *Peziza helminthosporii* Blox., in ligno quercino udo putrescente a Selva. Sept. 1874, PAD.

Type locality: Woods (at Selva) in Treviso, Italy.

Habitat: on old wood, on decorticated wood, branches or branchlets of *Acer, Carpinus, Castanea, Fagus, Fraxinus angustifolius, Platanus occidentalis, Quercus, Salix,* and unknown hosts.

Distribution: Azores Islands, Belgium, Canary Islands, Czechoslovakia, France, Italy, Mexico, United States, Yugoslavia.

Exsiccatae specimens examined: On branch of *Fraxinus*, in *Fraxinus* grove, young trees, Compartment 17a, adjacent to forest road between Compartment 16a & 17a., Mirkovci, near Vinkovci, 26 Sept. 1987, Korf, Iturriaga & Zhuang, CUP 61824 (NT of *Peziza heterosperma*) and Disc. Exs.; On decorticated log, Beaver Dam brook, Natchang State Forest, 12 miles E of Willimantic, Connecticut, August 26, 1979, R. P. Korf, CUP 58139 and Disc. Exs.

Other specimens examined: AZORES ISLANDS: **Terceira:** On rotted wood, Fontinhas above Agualva, 8 April 1978, R. P. Korf, L. M. Kohn, N. Korf, A. Y. Rossman, CUP-MM 1907.

CANARY ISLANDS: **La Palma:** On old wood, Forest road south of Los Tilos, January 14, 1976, R. P. Korf, W. C. Denison, L. M. Kohn, M. A. Sherwood, CUP-MM 726; On *Castanea* sp. wood, Near mine entrance at km. mark 13, road between Buenavista and El Paso, January 18, 1976, R. P. Korf, W. C. Denison, L. M. Kohn, M. A. Sherwood, CUP-MM 904; **Tenerife:** On decorticated wood, Llano de los Viejos, Monte de las Mercedes, December 28, 1976, R. P. Korf, R. Fogel, G. L. Hennebert, L. M. Kohn, CUP-MM 1196.

EUROPE: BELGIUM: Sur l'*Helminthosporium apiculatum,* Groenendael, PAD (*Belonidium marchalianum* holotype).

CZECHOSLOVAKIA: Carpati Rossici [=Ucrania Transcarpatica], ad lignum frondosum (in silvis virgineis montanis), August 1929, J. Velenovský, Flora rossica, PRM 149988 (as *Gorgoniceps Pilati* (HT), also as an unpublished transfer to *Durella*).

FRANCE: On wood of *Carpinus* sp., Bois de Loubieng, Orthez, 9. VIII. 1983, J. Vivant, comm. F. Candoussau 4302, CUP 61800; On

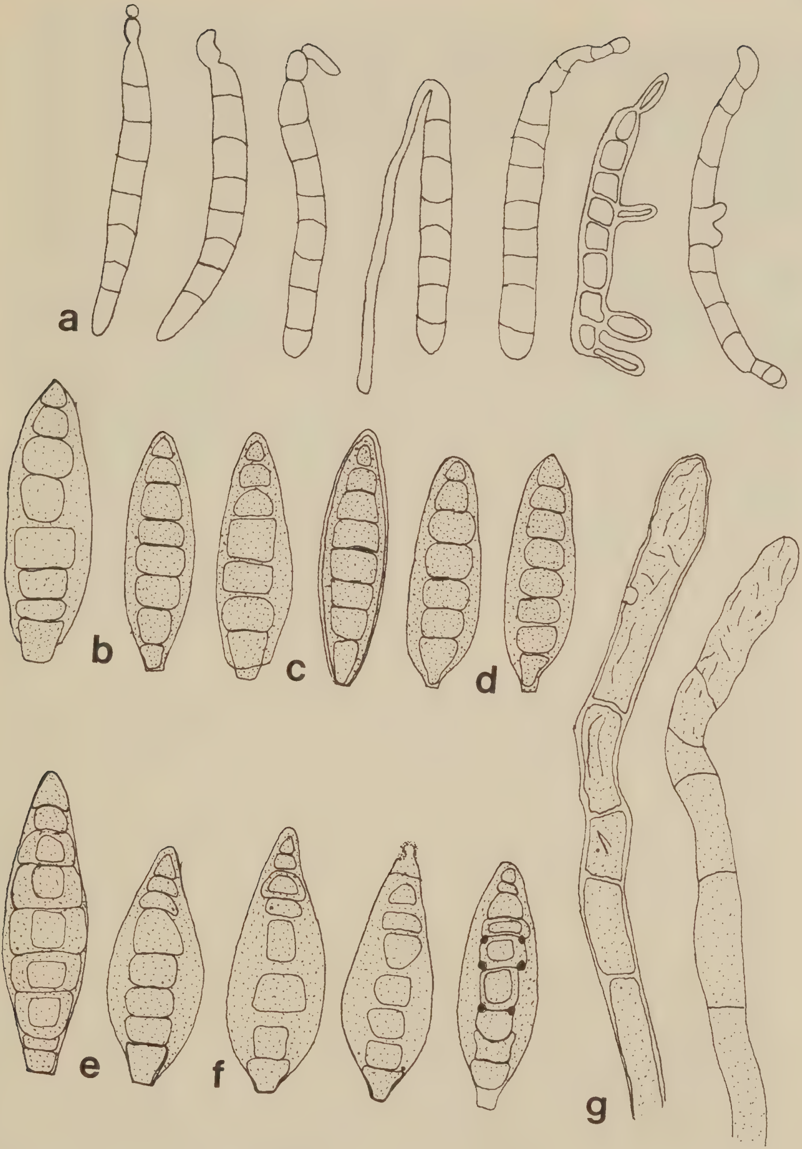


Figure 14. ***Strossmayeria basitricha***. **a,** ascospores germinating in apothecia; **b-f,** conidia; **g,** conidiophores. **a, f, g,** NT of *Peziza heterosperma;* **b,** HT of *Gorgoniceps iowensis;* **c,** CUP-D 1011; **d,** DAOM 37630; **e,** HT of *G. pilatii.* All ×1000.

Corylus sp, abandoned hazelnut orchard, Kerlouguen, near Poullaouen, Finistère, France, 18. IX. 1987, F. Candoussau, T. Iturriaga, R. P. Korf & W.-y. Zhuang, CUP 61868; On wood of *Corylus* sp., l. c., CUP 61869 (as *Pseudospiropes)*; On *Corylus* wood, l.c., CUP 61870, VEN; On wood, Forêt du la Saisine, west of Reffannes, about 10 km south of Parthenay, Dépt. Deux-Sèvres, 19. IX. 1987, F. Candoussau, T. Iturriaga, R. P. Korf & W.-y. Zhuang, CUP 61871, CUP 61872, VEN; On wood, l. c., CUP 61872, VEN; On rotted wood, l. c., CUP 61873, CUP 61874 and VEN, CUP 61875 and VEN.

YUGOSLAVIA: On branch of *Fraxinus,* in *Fraxinus* grove, young trees, compartment 17a, adjacent to forest road between compartment 16a & 17a, Mirkovci, near Vinkovci, 26 Sept. 1987, Korf, Iturriaga & Zhuang, CUP 61824 (NT of *Peziza heterosperma*), Disc. Exs., VEN; Same data, CUP 61825, Disc. Exs., VEN. On branchlet of *Fraxinus,* same data, CUP 61826 (material is too young); On decorticated branch of *Fraxinus,* same data, CUP 61828; On branchlet of *Fraxinus,* same data, CUP 61829 (Discomycete is too young, *Pseudospiropes* is good = *P. simplex);* On branchlet of *Fraxinus,* same data, CUP 61830; On twig of *Fraxinus,* same data, CUP 61831; On branch (decorticated) of *Fraxinus angustifolius* under large trees, woods S. of Vidor Creek, Compartment 16a, Mirkovci, near Vinkovci, 26 Sept. 1987, Iturriaga, Korf & Zhuang, CUP 61832, VEN [poor condition] and *Pseudospiropes simplex);* On decorticated *Fraxinus,* same data, CUP 61835; On decorticated wood, same data, CUP 61836 (too young) & *Pseudospiropes simplex;* On twig on branchlet of *Fraxinus,* same data, CUP 61837, VEN (too young) and *Pseudospiropes simplex;* On decorticated branch of *Fraxinus,* same data., CUP 61838 (as *Pseudospiropes simplex,* no *Strossmayeria* seen); On stump of *Fraxinus angustifolius,* woods S. W. of Vidor Creek, near Vinkovci, Yugoslavia, 25. IX. 1987, Iturriaga, Korf & Zhuang, CUP 61876 (as *Pseudospiropes* sp.); On the same stump of *Fraxinus angustifolius* as CUP 61876, same data, CUP 61877; On branch of *Fraxinus angustifolius,* Compartment #55, Beresinci Forest, 3 km E. of Privlaka, 12 km. S. of Vinkovci, Yugoslavia, forest stand ca. 25 years old, 25. IX. 1987, Iturriaga, Korf & Zhuang, CUP 61878, VEN; On branch of *Fraxinus angustifolius,* same data, CUP 61879; On cut end of branch of *Fraxinus angustifolius,* same data, CUP 61880 (as *Pseudospiropes* sp.); On wood chips of *Fraxinus angustifolius,* same data, CUP 61881 (as *Pseudospiropes* sp.); On cut ends of *Fraxinus angustifolius,* same data, CUP 61882; On decorticated branch of *Fraxinus angustifolius,* same data, CUP 61883; On decorticated wood of *Fraxinus angustifolius,* same data, CUP 61884; On rotted wood of *Fraxinus angustifolius,* same data, CUP 61885; On wood chip of *Fraxinus angustifolius,* same data, CUP 61886; CUP 61887; On decorticated wood, under large trees of *Fraxinus*, woods S. of Vidor Creek, Compartment 16a, Mirkovci, near Vinkovci, Yugoslavia, 26. IX. 1987, Iturriaga, Korf & Zhuang, CUP 61888; On decorticated wood, same data, CUP 61889, CUP 61890; On cut surface of trunk of *Fraxinus,* same data, CUP 61891; On branches of *Fraxinus,*

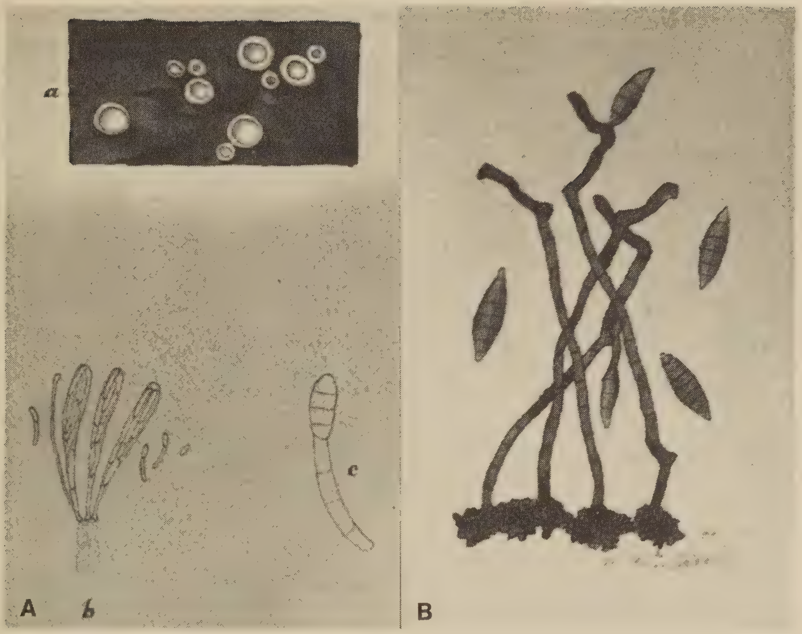


Figure 15. **Photographs of Schulzer's drawings accompanying his notes: A: a, b, c.** ***Peziza heterosperma*** (= ***Strossmayeria basitricha***): **a.** Apothecia. **b.** Asci with ascospores. **c.** Ascospore with appendage. **B.** ***Helminthosporium gongrotrichum*** (= ***Pseudospiropes*** **sp.**), conidiophores and conidia. All enlarged. See text.

same data, CUP 61892; On cut surface of hard wood of *Fraxinus,* under large trees of *Fraxinus,* woods S. of Vidor Creek, Compartment 16a, Mirkovci, near Vinkovci, 26. Sept. 1987, Korf, Iturriaga & Zhuang, CUP 61839, CUP 61931.

MEXICO: On rotted log, between Km. 79-80, on road from Oaxaca to Valle National, Oaxaca, 10. VIII. 67, K. P. Dumont, CUP-ME 162.

UNITED STATES: **Connecticut:** On decorticated log, Beaver Dam Brook, Natchang State Forest, 12 miles E of Willimantic, 26.VIII. 1979, R. P. Korf, CUP 58139. **Indiana:** Decorticate trunk, Sayres' Wood, Union Co., 7-25-17, F[ink] & F[uson] 60, CUP-D 10594 (73-76). **Iowa:** On old wood, Mt. Pleasant, July 12, 1905, (Seaver), *Gorgoniceps iowensis* Rehm, [holotype], S; On wood of *Platanus occidentalis,* Mt. Pleasant, 22. II. 1906, Fred J. Seaver, R.P.K. 2024 ex NY (as *Gorgoniceps ? iowensis*). **Maine:** Kittery Pt., July 3, 1922, R. Thaxter (as *Strossmayeria basitricha*), FH. **New York:** Canandaigua, Sept. 1888, O. F. Cook, No. 1470 (as *Belonidium basitrichum)*, BPI; On rotting stump (maple?), Lyndonville, 9. VIII. 1890, Dr. C. E. Fairman, R.P.K. 2015 ex

NY (as *Gorgoniceps iowensis*); On rotten oak wood, Jones's woods, Canandaigua, Sept. 11, 1900, E. J. Durand (as a new, unpublished species attributed to Rehm, of *Arachnopeziza,* with an epithet meaning sulfur-colored), and also as *Belonidium minutissimum* (Batsch) Phill.), CUP-D 1011 (73-37) ex CUP-A 5713, R.P.K. 1145, R.P.K. 1932 (ex Herb. Rehm, S); On hard moist chips in the woods, Lyndonville, Sept. 20, 1905, C. E. Fairman, CUP-D 448 (73-68); On chips in woods, Lyndonville, Sept. 1905, [Fairman], Det. Rehm (as *Belonidium marchalianum*), CUP-F 2122 (2-45); On chestnut log, Ringwood, Aug 29, 1931, C. L. Shear, R.P.K. 1558 ex NY; On *Acer*, Michigan Hollow, near Ithaca, Sept. 4, 1952, R. F. Cain, CUP 52833; On *Salix* wood in seepage area, Lodi Center Rd., Seneca County, 4. VIII. 1974, M.A. Sherwood 1847, CUP 54892; On wood of *Fagus,* along Sagamore Road, Raquette Lake, 11. IX. 1976, M. A. Sherwood, R.P.K. 4310; On decorticated wood, Hendershot Gulf, Alpine, 4.X.1977, R. P. Korf, CUP 56992; On rotted wood, Coy Glen, Ithaca, 25. X. 1979, R. P. Korf, CUP 58162; On wood, 6 Mile Creek, Ithaca, Nov. 24, '82, T. Iturriaga, A. Bujakiewicz, CUP 59720, 59721; On wood, near Waterfall Trail at the bridge, west end of Rensellaerville, Sept. 17, '83, T. Iturriaga S-8, CUP 59895; On wood, Lloyd-Cornell Preserve, Slaterville, 13. X. 83, R. P. Korf (Iturriaga S-9), CUP 59896; On decorticated wood, Huntington Camps, Raquette Lake, 6. IX. 1986, W.-y. Zhuang & R. P. Korf, CUP 61804. **North Carolina:** Ravenel's Forest, July 26, 1931, [Seaver], R.P.K. 2029 ex NY (as *Gorgoniceps iowensis*). **Tennessee:** Burbank, July-August 1887, R. Thaxter, FH. **Virginia:** On *Quercus* sp., Arlington Cemetery, July 7, 1929, C. L. Shear (as *Belonidium basitrichum*), BPI. **Wisconsin:** Devil's Lake State Park, near Madison, 4 Sept. 1953, R. P. Korf, R.P.K. 2775.

Illustrations: Saccardo, *Fung. ital.* pl. 113. 1877 (*Belonidium basitrichum* and *Helminthosporium belonidium*); Schulzer, *Oest. Bot. Zeitsch.* **31:** 314. 1881; Schulzer's drawings in his manuscript, never published, kept in the National & University Library Kr. Sveuc Bibliotekaat Zagreb University, are reproduced here (Fig. 15); Penzig & Saccardo, *Icones Fungorum Javanicorum,* Table 54, Fig. 1. 1904 (*Belonidium albo-cereum*); Velenovský, *Monogr. Discomycet. Bohem.* **2:**. Pl. 3, Fig. 20. 1934 (*Gorgoniceps Pilati);* this paper, Fig. 2e, 5a, 6d, 13, 14, 15.

Etymology: The epithet *basitricha* is from the Latin, referring to basal "hairs" (conidiophores).

Notes: *Peziza heterosperma* Schulzer (1878) [≡ *Strossmayeria rackii* Schulzer (1881)] is neotypified here with material collected on a special trip to the type locality at Vidor forest, close to Vinkovci, Yugoslavia, to search for topotypic material, since the holotype is lost. *S. rackii* Schulzer was described as occurring together with *Helminthosporium gongrotrichum* Corda. The epithet "*rackii*" is superfluous, since three years earlier Schulzer had described the fungus from the same specimen in almost exactly the same words as a new species, *P. heterosperma.* Schulzer's herbarium apparently no longer exists, and his specimens are difficult if not impossible to locate (M. Tortić, pers. comm.). Attempts to locate type material in any Yugoslavian herbarium met with failure. All these reasons made it desirable for a topotypic neotype to be designated. *Peziza heterosperma* is a later synonym and does not upset the currently accepted name, *Strossmayeria basitricha*. Topotypic material was found in abundance (Korf, el al., 1988). The number of germinating ascospores in the Yugoslavian collections of *S. basitricha,* including the neotype of *P. heterosperma* was surprising, because in every collection most of the ascospores inside and outside the asci were germinating when collected. Germination occurs at one or both ends of the ascospore and seldom from the central cells, 3-4 cells may germinate at the same time. Germ tubes frequently are thick and short, and resemble very much the "appendages" that Schulzer showed in his drawing of *S. rackii* (Fig. 15) and in Schulzer (1881). In general, European collections seem to have longer ascospores and a wider conidial basal scar than specimens of *S. basitricha* from other localities.

The HT of *G. pilatii* Vel. and a specimen from FH (Thaxter, July-August 1887, Tennessee) have the peculiarity that the apothecia are clearly pseudostipitate, more evidently so than in any other specimens of *S. basitricha*.

There are other collections which vary slightly from *S. basitricha,* but clearly belong to this species. Collection CUP 52833 has ascospores whose cells disarticulate inside the ascus. Collection CUP-D 1011 has a yellow mold associated with it, which Durand considered as a yellow subiculum and annotated the packet as a new species of *Arachnopeziza*, a name apparently provided to him by Rehm, but never published. The HT of *G. iowensis* and of CUP 58162 usually have a verrucose gel sheath on the ascospores. CUP 58162 also has inflated apices of paraphyses, up to 5.9 µm wide. CUP 56992 has yellow apothecia. CUP 54892 has brown, discoid apothecia.

6. ***Strossmayeria confluens*** (Seaver & Waterston) Iturriaga & Korf, *comb. nov*. (Fig. 3e, 4e, 16).

≡ *Gorgoniceps confluens* Seaver & Waterston, *Mycologia* **32**: 399. 1940. (!!) (!)

Misapplication: *Gorgoniceps pumilionis* Rehm, by Seaver, *Mem. New York Bot. Gard.* **6**: 506. 1916.

Anamorph: *Pseudospiropes* sp.

Apothecia turbinate, sessile with a small point of attachment, 0.2-0.5 mm in diameter, gregarious and often confluent, upper receptacle white or whitish when rehydrated, cream colored, beige or light brown when dry, darker toward the base, usually dark brown, margin and disc concolorous with upper receptacle, disc granulose. Ectal excipulum of textura oblita, J+ with a strong blue green (in the HT) to blue reaction, basal cells shorter and those marginal or closer to the margin longer, 13-15 (-27) × 2.2-3.7 µm. Asci clavate, (91-) 93-118 (-130) × 13-19 (-22) µm. Ascospores cylindrical-clavate, hyaline, J+, with refractocell present or not, cells not enlarged, with or without disintegrating cells, biseriate or triseriate, 32-43 (-52) × 2.9-4.4 (-5.8) µm, (6-) 7 (-8)-septate; gel sheath thick and markedly verrucose or papillate, 1.5-2.2 (-2.9) µm wide. Paraphyses long and filiform, simple, seldom divided, septate, broader at the clavate apex, 1.5-2.2 µm wide at the middle, 2.2-3.7 µm wide at the apex. Conidiophores brown, septate, flexuous, with evident protruding scars, lighter toward the apex, (3.7-) 4.4-7.3 µm wide at the middle, wider and rounded at the base where they are (4.4-) 7.3-11 µm wide, wall 0.7-1.5 µm thick. Conidia fusiform, brown, scarce, 29-44 × (8.1-) 9.5-12 µm, basal scar width 1.5-3.0 (-3.4) µm, septa 5-7 (-10); aberrant conidia present in the HT, cylindrical-fusiform, 71-127 × 12-15 µm, basal scar 3.7 µm broad.

Holotype: On wood, Nov. 29-Dec. 14, 1912, S. Brown, N.L. Britton, F. Seaver, Explorations of Bermuda 1487, [on rotten wood and on palm stems], NY; isotype in R.P.K. 2017.

Paratype: On *Sabal bermudiana,* Paget Marsh, F. J. Seaver & J. M. Waterston, Dec. 2, 1938, Fungi of Bermuda 62, NY (as *Gorgoniceps confluens*).

Type locality: Bermuda.

Habitat: On decomposed wood, principally decorticated, on *Myrica,* on *Schinus terebinthefolium,* on spiny woody involucre of ?*Sloanea,* and on palm (*Sabal*) stems and petioles.

Distribution: Bermuda, Canary Islands, Dominica, Jamaica, Panama.

Exsiccatae specimens examined: None.

Other specimens examined: BERMUDA: On wood, Nov. 29-Dec. 14, 1912, S. Brown, N. L. Britton, F. J. Seaver, NY Explorations of Bermuda 1437, R.P.K. 2016, Authentic; On *Sabal bermudiana* Bailey, Paget Marsh, Bermuda, 1/8/22, H. H. Whetzel, CUP 35005 (as *G. confluens*); On *Sabal bermudiana* Bailey, Paget Marsh, Bermuda, 1/29/22, H. H. Whetzel, CUP 35006, R.P.K. 1187; Old petioles, *Sabal blackburnianum,* Paget Marsh, 8. I. 1922, Whetzel, R.P.K. 2022 ex NY (as *Gorgoniceps pumilionis*); On *Sabal,* Paget Marsh, "small spores," Dec. 6, 1940, F. J. Seaver & J. M. Waterston, Fungi of Bermuda 407, NY (as *G. confluens*); On *Sabal,* Paget Marsh, Dec. 6, 1940, F. J. Seaver & J. M. Waterston, Fungi of Bermuda 410, NY (as *G. confluens*); On *Sabal,* Paget Marsh, Dec. 6, 1940, F. J. Seaver & J. M. Waterston, Fungi of Bermuda 418, NY (as *G. confluens*); On *Myrica cerifera*, Paget Marsh, Sept. 13, 1941, F. J. Seaver & J. M. Waterston, Fungi of Bermuda 460a, NY (as *G. confluens*); On *Myrica cerifera*, Paget Marsh, Sept. 13, 1941, F. J. Seaver & J. M. Waterston, Fungi of Bermuda 461a, NY (as *G. confluens*); On rotten stick, Walsingham, Bermuda, 10/14/44, J. M. Waterston, CUP 35098 (as *G. confluens*) R.P.K. 1186; On branch, Smith's Parish, along Store Hill Road, January 17, 1980, R. P. Korf, leader, et al., CUP-BE 1; On fallen petiole of *Sabal bermudiana*, Paget Parish, Paget Marsh, January 19, 1980, R. P. Korf, leader, et al., CUP-BE 35; On *Schinus terebintefolium*

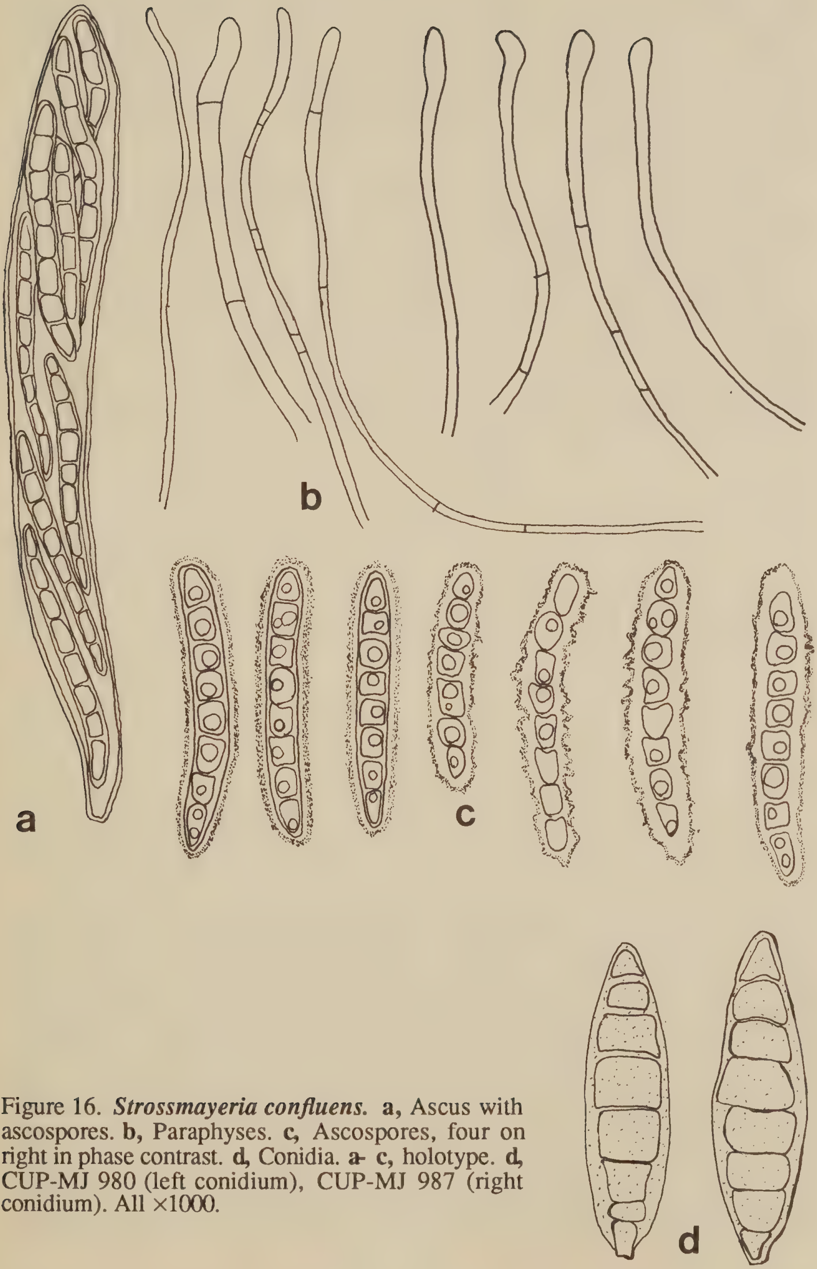


Figure 16. ***Strossmayeria confluens.*** **a,** Ascus with ascospores. **b,** Paraphyses. **c,** Ascospores, four on right in phase contrast. **d,** Conidia. **a- c,** holotype. **d,** CUP-MJ 980 (left conidium), CUP-MJ 987 (right conidium). All ×1000.

[stems], Smith's Parish, North Nature Preserve, January 21, 1980, R. P. Korf, leader, et al., CUP-BE 97; On wood, Smith's Parish, Spittal Pond, January 21, 1980, R. P. Korf, leader, et al., CUP-BE 102 (part of this collection in herb. M. B. Bigelow); On carbonous pyrenomycete/hyphomycete, Hamilton Parish, North Nature Reserve near Mangrove Lake, January 21, 1980, R. P. Korf, leader, et al., NY, Rossman-BER-151 (as *Strossmayeria* sp.).

CANARY ISLANDS: **La Palma:** On wet wood, Forest road south of Los Tilos, January 14, 1976, R. P. Korf, W. C. Denison, L. M. Kohn, M. A. Sherwood, CUP-MM 713; On wood, Forest road south of Los Tilos, January 14, 1976, R. P. Korf, W. C. Denison, L. M. Kohn, M. A. Sherwood, CUP-MM 714.

DOMINICA: On face of line of dehiscence of spiny involucre of ?*Castanea* or ?*Sloanea*, woods and roadside near Bee House, Springfield Estate, 7 miles from Roseau, elev. 1200 ft., June 21, 1970, R. P. Korf, leader, et al., CUP-DO 81; On wood, Cochrane Estate, above Roseau, elev. approx. 1500 ft., June 28, 1970, R. P. Korf, leader, et al., CUP-DO 261.

JAMAICA: On very rotted twig, Dolphin Head, Hanover Parish, January 22, 1971, R. P. Korf, leader, et al., CUP-MJ 690, NY-K. P. D. 1965; On *Rubus ellipticus* J.E. Smith stems, creek below Pine Grove Villas, 0.9 mi. North of Guava Ridge, 3400 ft., St. Andrew Parish, Dec. 8, 1986, R. P. Korf, T. Iturriaga, W.-y. Zhuang, CUP-MJ 978, VEN 210435; On decorticated log, trail above Bath Fountain Hotel, Bath, St. Thomas Parish, elev. 650 ft., December 12, 1986, R. P. Korf, T. Iturriaga, W. Y. Zhuang, CUP-MJ 1111, VEN 210554.

PANAMA: Canal Zone: Barro Colorado Island, 18 July 1945, G. W. Martin 6067, ISC ex IA 380550 (as *Belonium sordidum,* "Part A: big piece of wood"); On fallen palm trunk, Canal Zone: Barro Colorado Island, 18 July 1945, G. W. Martin 6067, USDA, ex Mycological Collection of the Univ. of Iowa.

Illustrations: Seaver, F. J., *Mycologia* **38:** 551. 1946; Seaver, F. J. 1951. *N. Amer. Cup-Fungi (Inoperc.).* pl. 110; this paper, Fig. 3e, 4e, 16.

Etymology: The epithet *confluens* is from the Latin, meaning thickly clustered.

Notes: The distinctive characters of this species are presence of a thick, verrucose gel sheath on ascospores, refractocells present or not in the ascospore, but when present, not enlarged, and disintegrating cells present or not. This species can be distinguished from *S. jamaicensis* in that asci and ascospores are thinner and in the absence of enlarged refractocells in the ascospores. Anamorph characteristics were very noticeable in the collections studied. The absence or poor quality of the anamorph was evident in most of the collections studied. Aberrant conidia and/or different kinds of conidia present, not seen before, were observed: obclavate in CUP-MJ 1111 (4 seen), fusiform with one flat side in CUP-MJ 978 (1 seen) and CUP-MJ 987 (3 seen) but also one fusiform conidium seen. Aberrant obclavate multiseptate conidia, 10-14-septate, seen in

CUP-MJ 980 (8 seen), together with four fusiform 7-septate conidia. In the HT only four conidia were seen, 2 fusiform but in a poorly preserved state, and 2 aberrant. In CUP-MM 714 many conidia measured were obtained from multiple-ascospore cultures prepared in the field by Professor Korf.

Waterston (1947) published a list of examined specimens of *G. confluens* in his book, *The Fungi of Bermuda*. There Waterston indicates that the type specimen was "listed as *G. pumilionis* Rehm, by Seaver (1916: 506), but see also Seaver (1946: 551, 552)."

Seaver's (1916) paper on Bermuda Fungi cites no specimen number for *Gorgoniceps pumilionis* but mentions that it was the only *Gorgoniceps* collected (p. 501) during a "two weeks collecting trip (November 29-December 14, 1912)." It was in 1940 that Seaver and Waterston designated this specimen as the type of *G. confluens*. The 1916 identification is thus merely a misidentification.

Seaver and Waterston (1940) (repeated in Seaver, 1946, 1951) indicated that *G. confluens* is very similar to *G. iowensis* Rehm (treated here as a synonym of *S. basitricha*), which was described from material collected by Seaver in Iowa, but indicated that the "spores of the Bermuda specimens seem to be larger."

7. ***Strossmayeria dickorfii*** Iturriaga, *sp. nov.* (Fig. 17a-e).

Ab Strossmayeriae *speciebus aliis ascis aliquando 6 sporas continentibus, conidiophoro typi* Pseudospiropedis nodosi *characteristici, et conidiis fusiformibus latere uno applanatis differt.*

Anamorph: *Pseudospiropes* sp.

Apothecia turbinate when young, discoid, flatly appressed to the substrate when mature, sometimes with an evident whitish subiculum, receptacle cream colored, disc cream-ochraceous. Ectal excipulum textura oblita, 26-30 µm thick in median section, J+, cells 8.0-12 × (1.5-) 2.2-2.9 µm. Asci 6-8-spored, saccate with a very short stipe, (84-)112-142 (-153) × 13-19 (-21) µm. Ascospores cylindrical-clavate to sub-fusoid, hyaline, J+, cells uniform but sometimes disarticulating inside and outside the ascus, biseriate, (29-) 34-40 (-60) × (3.7-) 4.4-5.1 (-7.3) µm, (3-) 7-septate, gel sheath 1.0-1.5 µm thick, verrucose. Paraphyses cylindric, 2.2 µm wide at the tips. Conidiophore brown, septate, flexuous, with thick walls and evident, grossly protruding scars, (6.6-) 7.3-9.5 (-11) µm wide at the middle, base swollen to 10-11 µm wide. Conidia fusiform with one flat or flatter side, brown except apical cell which is hyaline, sometimes enlarged, and usually of an irregular shape, seeming to be a germinating cell but usually broken, 32-44 (-56) × 12-15 µm, basal scar width (3.7-) 4.4-6.0 (–6.6) µm, septa (4-) 6-7 (-9), dark septa sometimes present.

Holotype: On a twig, trail from Km. 12.2 to falls of Rio de la Mina, El Yunque, elev. 650 m., June 8, 1970, R. P. Korf, leader et al., CUP-PR

3929.

Type locality: El Yunque, Puerto Rico.

Habitat: On a twig of unknown host.

Distribution: Puerto Rico.

Exsiccatae specimens examined: None.

Other specimens examined: None.

Illustrations: Fig. 17a-e in this paper.

Etymology: The epithet *dickorfii* is in honor of Professor Richard (Dick) Korf.

Notes: Diagnostic features for this species are the presence (sometimes) of a subiculum, occasionally 6-spored asci, saccate asci, frequently with disarticulating ascospore cells, *Pseudospiropes nodosus* type of conidiophore, fusiform conidia with one flat side, and 6-7-septate conidia. *S. dickorfii* differs from *S. atriseda* in the shape of the conidia, being fusiform with one flatter side for *S. dickorfii* and fusiform for *S. atriseda;* in ascus shape, being short and stout in *S. dickorfii* and long and clavate in *S. atriseda;* and in the position of the dark cells in the conidia, being penultimate in *S. dickorfii*, and sometimes apical and/or basal in *S. atriseda*.

8. ***Strossmayeria immarginata*** (Pat. & Gaill.) Iturriaga, *comb. nov.* (Fig. 17f-g).

≡ *Beloniella immarginata* Pat. & Gaill., *Bull. Soc. Mycol. France* **4**: 100. 1888. (!!)

≡ *Belonidium immarginatum* (Pat. & Gaill.) Sacc., *Syll. Fung.* **8**: 498. 1889.

Anamorph: *Pseudospiropes* sp.

Apothecia turbinate, sessile but with a small point of attachment to the substrate, 0.15-0.20 mm in diameter when dry, 0.2-0.3 mm in diameter when rehydrated, solitary (but this is not certain since the type specimen is poor), receptacle yellowish when dry, white when rehydrated, base brownish and composed of brown irregular cells, from which the conidiophores also arise, disc concolorous with upper receptacle. Ectal excipulum of textura oblita, 18 µm thick in the middle, 9.0-11 µm thick at the flanks, J+, composed of long rectangular cells with gelatinized walls, 7.3-11 (-12) × (1.5-) 2.2-2.9 (-3.7) µm , apical cells with rounded ends. Medullary excipulum and sub-hymenium of textura intricata, indistinguishable, intermixing with the irregular cells from the base of the apothecium. Asci clavate, 88-107 × (9.3-) 11-13 µm, base of the asci 3.7 (-5.6) µm wide. Ascospores cylindrical-clavate, hyaline, J+, with uniform cells, 30-51 × 2.9-3.7 µm, (3-) 4-7-septate, frequently 4-septate, smaller ascospores with fewer septa and larger ones with more septa, gel sheath verrucose, 1.0 µm thick. Paraphyses long and filiform, simple, septate, slightly swollen and rounded at the apex, 1.5 (-2.2) µm wide in the middle,

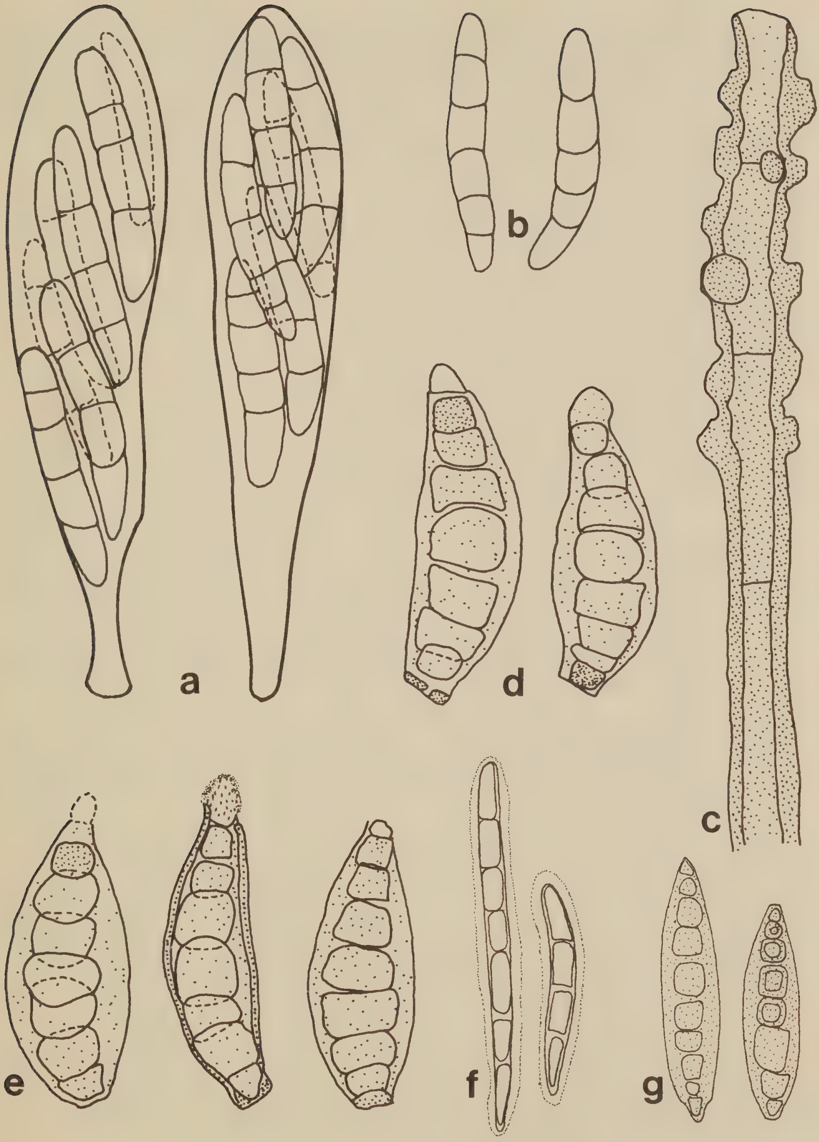


Figure 17. ***Strossmayeria*** **spp. a-e,** *S. dickorfii* (HT). **a,** asci with ascospores; **b,** ascospores; **c,** conidiophore; **d, e,** conidia. All × 1000. **f, g,** ***S. immarginata*** (HT). **f,** ascospores; **g,** conidia. Both × 1000.

2.2-2.9 (-3.7) µm wide at the apex. Conidiophores brown, straight, with protruding scars, 5.1-5.9 (-7.3) µm wide in the middle, base somewhat swollen, rounded, 7.3-11 µm wide, wall 0.7-1.5 µm thick. Conidiogenous cell lighter in color than the rest of the conidiophore, at least in its upper terminal part. Conidia fusiform with a short basal pedicel, brown, (23-) 32-35 (-37) × 7.3-9.5 µm, basal scar narrow, width 1.0-2.2 µm, septa (3-) 7-9.

Holotype: Blanc laiteux opalin, Puerto Zamuro, 15 Juin 1887, Herb. N. Patouillard 56, Gaillard, FH. [Part of the HT (one slide) at NY as KPD 3167 ex FH Pat. Herb. 56].

Type locality: Puerto Zamuro, at the margin of the Orinoco River, Estado Bolívar, Venezuela.

Habitat: On dead wood of unknown host.

Distribution: Venezuela.

Exsiccatae specimens examined: None.

Other specimens examined: None.

Illustrations: Patouillard, N. & A. Gaillard, *Bull. Soc. Mycol. France* **4:** Pl. XVIII, 3, 3a, 3b, 1888; this paper, Fig. 17f-g.

Etymology: The epithet *immarginata* is from the Latin meaning without a margin.

Notes: Saccardo's (1889) transfer to *Belonidium immarginatum* was accompanied by a Latin translation of the original French description. Our measurements agree with Patouillard and Gaillard's (1888) in everything but ascospore width, for which our values are lower than theirs, "40-43 × 4-5 µ." They report no reaction in iodine, but we found ectal excipulum and ascospores blueing in Melzer's Reagent. They reported only 4-septate ascospores.

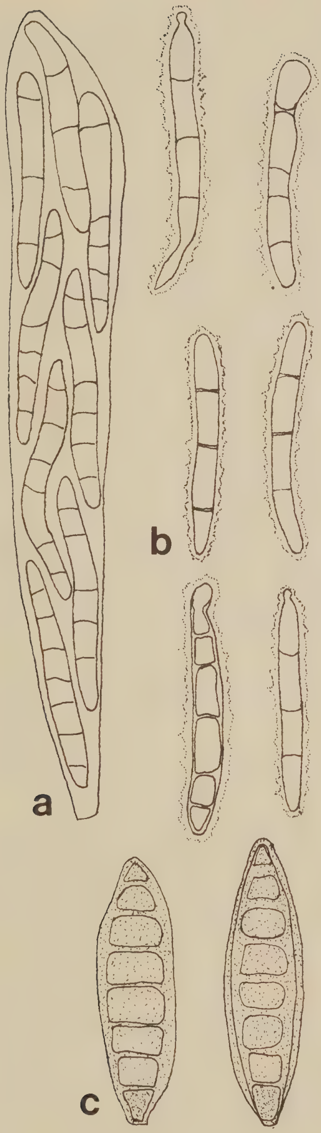
The outstanding morphological features of *S. immarginata* are the frequency of 4-septate ascospores, the small size of the conidia, the small conidial basal scar, and the short ascus length. Ascospore size is similar to that in *S. bakeriana*.

This fungus was cited by Pfister (1977), who indicated the basionym and the combination in *Belonidium*, but without comment on its taxonomic position. It was also cited by Dennis (1970) under omitted species. Dennis wrote: "Perhaps a lichen." The holotype is not in good condition; just one or two apothecia are left. The part of the HT at NY is just a slide with a squash mount of one apothecium and a few conidiophores and conidia, probably in glycerine.

9. ***Strossmayeria introspecta*** (Cooke) Iturriaga, *comb. nov.* (Fig. 1, 2b, 2f, 3h, 4f, 6e, 18).

≡ *Peziza introspecta* Cooke, *Hedwigia* **14:** 84. 1875. (!!)
≡ *Belonidium introspectum* (Cooke) Sacc., *Syll. Fung.* **8:** 498. 1889.

Anamorph: *Pseudospiropes* sp.



Apothecia turbinate, 0.2 to 1 mm diameter, usually confluent, sometimes gregarious, seldom scattered, substipitate, upper flank of receptacle beige, turning white to cream colored when rehydrated, pure white to gray when fresh, darker toward the base, disc concolorous with upper receptacle. Base of the apothecium composed of brown to irregular brown cells, with its anamorph, *Pseudospiropes*. Ectal excipulum of textura oblita, 26-39 µm thick in median section, J+, composed of long rectangular cells, apical cells with rounded, slightly swollen tips, cells 8.8-15 (-20) × (2.2-) 2.9 (-3.7) µm, basal cells brown and of textura angularis. Medullary excipulum and subhymenium mixed, both thin, of textura intricata embedded in a gel. Asci 8-spored, clavate, with brown dextrinoid cytoplasmic contents when young, arising from croziers, (93-) 99-135 × (9.3-) 11-13 (-15) µm. Ascospores cylindrical-clavate, hyaline, J+, with uniform cells, biseriate to usually triseriate, (23-) 29-40 × 2.9-4.4 (-5.1) µm, 3 (-7)-septate, germination frequently seen, inside and outside the ascus either by production of narrow germ tubes or by production of bleb-like structures which are probably phialides, gel sheath smooth to verrucose, 0.7-1.5 µm thick. Paraphyses long and filiform, simple or divided, septate, swollen at the apex, 1.5-2.2 µm wide in the middle, 2.9-3.7 µm wide at the apex, granulose contents in the cytoplasm seen in one specimen. Conidiophore brown, straight, with thick walls and scars present, 5.1-5.9 (-7.3) µm wide in the middle, base swollen. Conidia fusiform, with a prominent short basal pedicel-like cell,

Figure 18. ***Strossmayeria introspecta.*** **a**, ascus with ascospores; **b**, ascospores (some germinating); **c**, conidia. **a.**, **b**, HT; **c**, R.P.K. 1566 [IT ex NY 762]. All × 1000.

brown, basal and apical cells usually darker than the rest, (29-) 34-41 × (7.3-) 9.0-12 µm, basal scar width 2.2 (-2.9) µm, 5-7 (-10)-septate.

Holotype: On rotten wood, Newfield, N. J., July 14, Ellis 2160 K; isotypes in CUP-D 3773 (73-56), R.P.K. 1709, CUP-D 8715 (73-59), NY (Ellis 2160) [Note on packet mentions the presence of an *Helminthosporium* (prob. *H. septemseptatum* Pk.)], R.P.K. 1566.

Type Locality: Newfield, New Jersey, U. S. A.

Habitat: on rotten wood of unknown hosts, on decorticated wood, and on *Fraxinus*.

Distribution: All collections known are from U.S.A.

Exsiccatae specimens examined: Korf & Gruff, Discomycetes Exsiccatae, to be issued shortly, Coy Glen, Ithaca, New York, September 30, 1982, R.P. Korf, CUP 59716; On decorticated wood, Freese Road extension, Fall Creek, Varna, NY, 22. vii. 1960, W. C. Denison, R. T. Moore, R. P. Korf, et al., R.P.K. 2968.

Other specimens examined: UNITED STATES: Oct. 1878, with conidia, Cke. says very near *P. minutissimum* Blox. (as *Peziza introspecta*) Ellis 3171(762), NY [Poor specimen], R.P.K. 1565; Newfield, N.J., Oct. 1878, Ellis, CUP-D 8714 (73-58) (ex NY Ellis 3171) (as *Peziza introspecta*) [well-preserved specimen]; On *Fraxinus*, Waverly, October 1899, R. Thaxter (as *S. basitricha*, annotated by M. Sherwood), FH; Belmont, Massachusetts, October 1886, R. Thaxter (as *S. basitricha*, annotated by M. Sherwood), FH; On decorticated wood, Coy Glen, Ithaca, N.Y., Sept. 30, 1982, R. P.Korf, CUP 59716 [referred to as "S-3" in Iturriaga & Israel, (1985)].

Illustrations: Iturriaga & Korf, *Mycotaxon* **20:** 182, Fig. 1-3, 1984; Iturriaga & Israel, *Canad. J. Bot.* **63:** 196-199, Fig. 1-12, 1985; this paper, Fig. 1, 2b, 2f, 3h, 4f, 6e, 18.

Etymology: The epithet *introspecta* is from the Latin, meaning looked at internally.

Notes: This species may be distinguished from *S. basitricha* because of its very frequently 3-septate ascospores and by the conidial pedicel-like basal cell. The 3-septate ascospores frequently have been seen germinating indicating that they are mature. The anamorph is of the *Pseudospiropes simplex* type. There are granulose contents in the cytoplasm of paraphyses in CUP 59716.

10. ***Strossmayeria jamaicensis*** (Seaver) Iturriaga & Korf, *comb. nov.* (Fig. 4h-i, 6f, 19).
≡ *Gorgoniceps jamaicensis* Seaver, Mycologia 38: 552-553. 1946. (!!)

Anamorph: Probably *Pseudospiropes* sp.

Apothecia discoid, sessile with a small point of attachment, 0.2-0.5 mm. wide, gregarious but not losing their individuality, upper receptacle cream colored when dry, white when rehydrated, brown toward the base, margin and disc concolorous with upper receptacle, disc granulose, whole apothecium turning lemon-yellow in 2% aqueous KOH and exuding a similarly colored substance into that medium. Ectal excipulum of textura oblita with long rectangular cells, J+, terminal cells with rounded apex, (9.5-) 12-15 (-17) × (2.2-) 2.9 (-3.7) µm. Asci clavate, 105-143 (-148) × (17-) 19-21 (-23) µm, base 3.7-5.6 µm wide, arising from repeating croziers. Ascospores cylindric, hyaline, J+ reaction very strong in spore and gel layer, with usually one (seldom two) enlarged refractocells (best seen in Soluble Blue 706-lactic acid), (31-) 33-46 (-49) × 4.4-8.0 (-9.3) µm, (1-) 7-septate, gel layer thick and very evidently verrucose, 2.2-3.7 µm thick. Paraphyses long and filiform, simple, septate, swollen at the apex, (0.7-) 1.5 (-2.2) µm at the middle, (1.5-) 2.2 (-2.9) µm at the apex. Conidiophore brown, flexuous, with scars, lighter toward the apex, 5.9-8.0 (-9.5) µm wide at the middle, base rounded 6.6-8.0 (-10) µm wide, wall 0.7-1.5 µm wide, arising from a mass of brown roundish to irregular cells located at the base of the apothecia. Conidia fusiform with one flattened side, tapering toward the two ends, one end pointed and the other broader, frequently with an enlarged cell (as with ascospores), dematiaceous with two middle cells darker and two end cells lighter, (25-) 26-29 (-32) × (6.6–) 7.3-8.0 (-8.8) µm, basal scar (0.7-) 1.5 (-2.2) µm, 3 (-5)-septate.

Holotype: Very small, white, Chester Vale, 3000-4000 Ft., wet mountainous region, Jamaica, December 21-24, 1908, W.A. Murrill and Edna L. Murrill 311, Det. F. J. Seaver, [On bamboo, *Bambos vulgaris*], NY; isotype in R.P.K. 2019.

Type locality: Jamaica.

Habitat: On culms of *Bambusa vulgaris* and stems of *Rubus ellipticus*.

Distribution: Only collections known are from Jamaica.

Exsiccatae specimens examined: None.

Other specimens examined: JAMAICA: On *Rubus ellipticus* J. E. Smith stems, creek below Pine Grove Villas, 0.9 miles north of Guava Ridge, 3400’, St. Andrew Parish, 8 XII, 1986, R. P. Korf, T. Iturriaga, W.-y. Zhuang, CUP-MJ 980.

Illustrations: This paper, Fig. 4h-i, 6f, 19. Fig. 19b, representing an ascus with ascospores and an ascospore outside, is a machine copy of Seaver's drawing which is a part of the holotype. Apparently this drawing was never published.

Etymology: The epithet *jamaicensis* is from the country name where the type was collected.

Notes: The main features of this species are the shape, width, and cell characteristics (enlarged refractocell) of the ascospores. Though measurements and characteristics are given for the dematiaceous mold found together with this species, we are not certain that this is the anamorph of *S. jamaicensis*, because many of the conidia encountered do not seem to be referable to *Pseudospiropes*. In just one case, one *Pseudospiropes*-type of conidium was seen (see drawing). Neither the dematiaceous fungus nor the presence of the enlarged refractocells was described by Seaver. In CUP-MJ 980 a dematiaceous obclavate conidium 190 × 15 µm was observed

Our measurements agree with Seaver's (1946) in all structures but the ascospores. In this case his measurements, "9-10 × 50-55 µ," are larger than ours.

With the holotype specimen there is another dematiaceous mold with helicoid conidia, but that is located on a different part of the substrate than where the *Strossmayeria* apothecia are found.

The ascospores in Melzer's Reagent look like they are in flames, because of the refraction of the irregularly warted gel that surrounds them. No germination of any ascospore was seen.

11. ***Strossmayeria japonica*** Iturriaga, *sp. nov.* (Fig. 20).

Ab S. atriseda *ascosporis cylindrico-clavatis, majoribus, conidiis obclavatis vel fusiformibus longioribus 4-6 septatis praeditis differt.*

Anamorph: *Pseudospiropes* sp.

Apothecia turbinate, up to 1 mm diameter, confluent, receptacle light brown when rehydrated, dark brown when dry, disc concolorous. Ectal excipulum of textura oblita, light brown, J+, cells (6.3-) 9.8-11 × 2.8-3.5 µm. Medullary excipulum and sub-hymenium thin. Asci clavate, 84-116 × 11-13 µm. Ascospores cylindrical-clavate, hyaline, J+, with uniform cells, (34-) 37-45 × 3.7-4.4 µm, 7-septate, gel sheath smooth, 1.0 µm thick. Paraphyses long and filiform, simple, septate, swollen at the apex, 1.5 µm wide in the middle, some over 2.9 µm wide in the apex. Conidiophore brown, straight, scars present, 7.3-9.5 µm wide in the middle, base swollen to 8.8-10 µm wide. Conidia obclavate to fusiform, brown, dark cells absent, dark septa present, (41-) 44-56 (-60) × 10-15 µm, basal scar width (3.7-) 4.4-5.1 µm, (3-) 4-6-septate.

Holotype: On decorticated wood, grounds of Chuzenji Kanaya Hotel, Chuzenji-kohan, Okku-Nikko, Tochigi Pref., Honshu, 26.VIII.1983, IMC$_3$ workshop people, CUP-JA 3718.

Type locality: Japan (Honshu).

Habitat: On decorticated wood of unknown host.

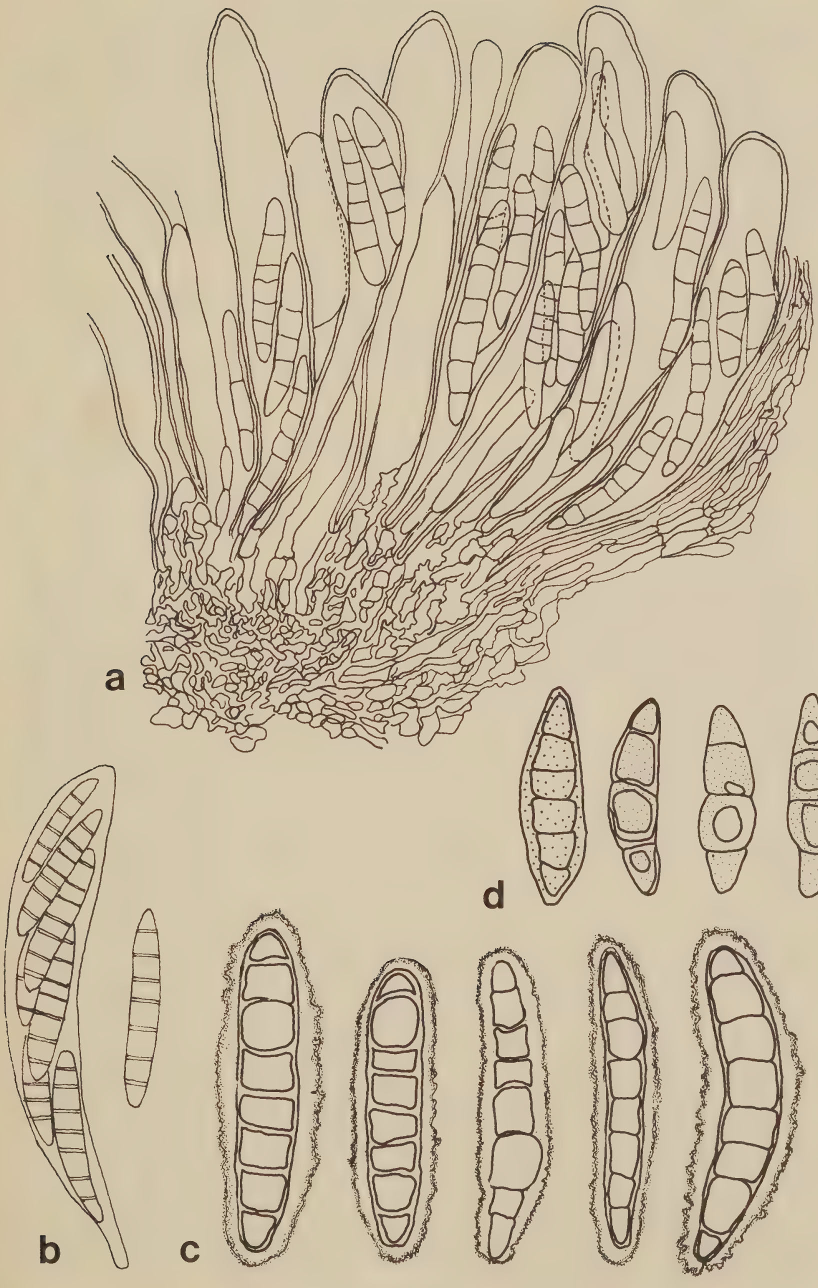
Distribution: The only collection known is from Japan.

Exsiccatae specimens examined: None.

Other specimens examined: None.

Illustration: This paper, Fig. 20.

Figure 19. ***Strossmayeria jamaicensis,*** (HT). **a,** median section through part of an apothecium, showing asci with ascospores, × 655; **b,** ascus and ascospores redrawn from Seaver's drawing in HT packet, magnification not stated; **c,** ascospores, × 1000; **d,** conidia, × 1000.


a
b
c
d

Etymology: The epithet *japonica* is taken from the country name where the type specimen was collected.

Notes: *Belonidium japonicum* Hara (1954) [as *Belanidium*] (see doubtful species) is most probably not a *Strossmayeria* as judged from the description.

The main features of this species are the brown color of the apothecia and the large, wide obclavate to fusiform conidia. This species differs from *S. atriseda* in shape and size of ascospores and conidia, and in number of conidial septa.

12. *STROSSMAYERIA JOSSERANDII* (Grelet) Bertault, *Rev. Mycol. (Paris)* **35:** 133. 1970. (Fig. 6g, 21).

≡ *Belonidium josserandii* Grelet, *Rev. Mycol. (Paris)* **15:** 38. 1950 ('*Josserandi*').(!!)

Anamorph: ***Pseudospiropes josserandii*** (Bertault) Iturriaga, *comb. nov.*

≡ *Helminthosporium josserandii* Bertault, *Rev. Mycol. (Paris)* **35:** 136. 1970. (!!)

Apothecia discoid when mature, sometimes turbinate when young, sessile to sub-stipitate, 0.5-1.0 (mostly 0.8) mm diameter, frequently confluent, yellowish to yellow-greenish when rehydrated, sometimes whiter when young and turning beige as they mature, brown toward the base, basal tissue brown or brownish, exuding in 2% KOH a yellow substance which soon disappears, disc from white to pale to light brown, granulose, margin folding inwards when young and then opening. Point of attachment very short, brownish to brown, conidiophores seeming to arise from this point. Ectal excipulum of textura oblita, composed of more or less parallel long hyphae, 32-45 µm wide, light brown to yellowish, clear, J+ turning blue-green with Melzer's reagent, cells 8.8-13 × 2.2 µm. Medullary hymenium and subhymenium not clearly differentiated. Asci clavate or saccate, arising from croziers, (97-) 103-131 (-140) × 11-19 µm. Ascospores cylindrical-clavate, hyaline, J+, with uniform cells which disarticulate in one specimen, biseriate to multiseriate, (32-) 35-55 × 3.5-5.1 (-6.6) µm, 6-7-septate, gel sheath smooth, 1.0-1.5 µm thick. Paraphyses long and filiform, simple or divided, septate, swollen at the apex, same length as, or a little longer than the asci, 1.5 µm wide in the middle, 2.2-2.9 µm wide at the apex. Conidiophores brown and lighter toward the apex, macronematous, mononematous, simple, slightly flexuous to flexuous, thick-walled, septate, 4.4-7.3 µm wide in the middle, base swollen to 7.3-8.8 (-14) µm wide. Conidiogenous cell polyblastic, integrated, terminal or intercalary, sympodial, cylindrical, slightly flexuous, bearing slightly protruding scars that are lighter in color than the rest of the conidiophore. Conidia brown, solitary, dry, acropleurogenous, simple, fusiform, sometimes constricted near the middle, tapering toward

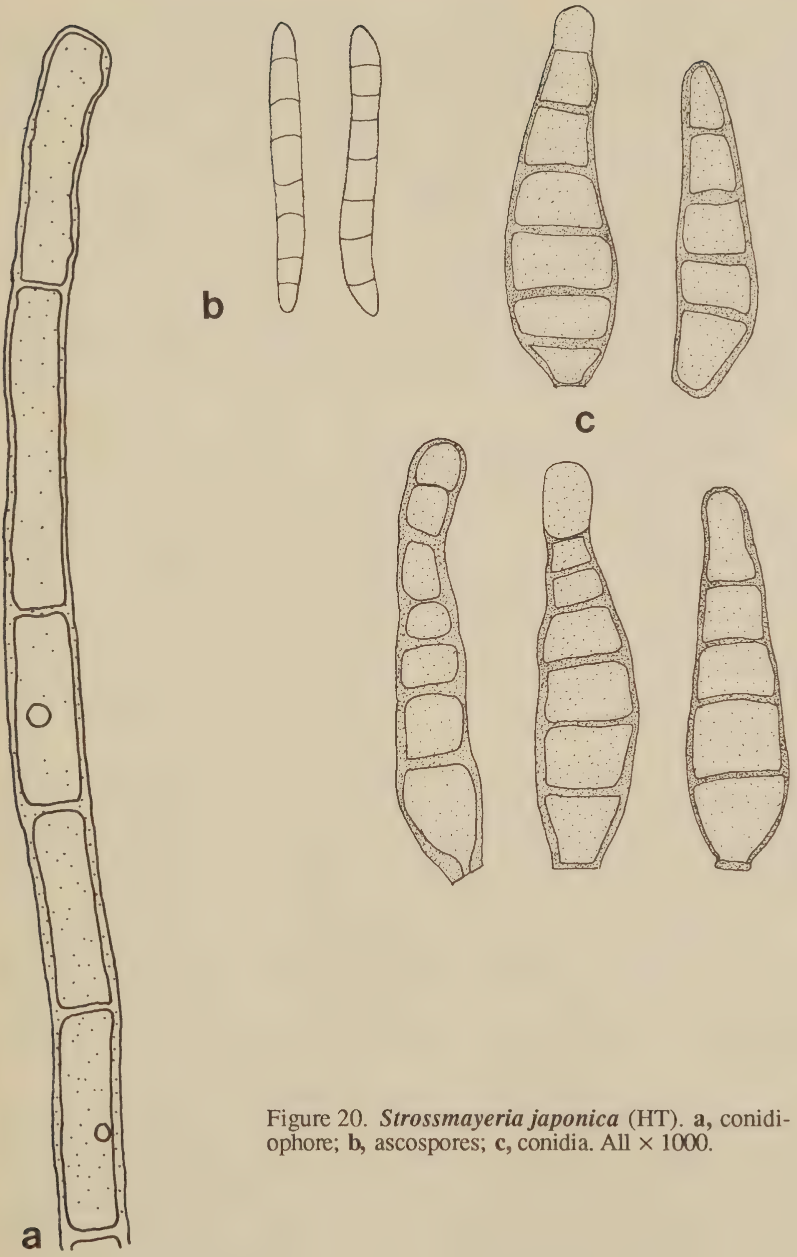


Figure 20. ***Strossmayeria japonica*** (HT). **a,** conidiophore; **b,** ascospores; **c,** conidia. All × 1000.

the apex, sometimes with a distinct beak, that may be relatively long (see Fig. 21a, and Notes), truncate at the base, (5-) 7-9-septate, sometimes with dark septa, basal cell usually dark brown, and basal septum always very thick and dark brown, usually all of the conidial septa with a dark thickening (the torus) around the pore between cells, 29-59 (-73) × (7.3-) 10-15 (-16) µm, basal scar width (2.2-) 2.9-3.7 (-4.4) µm.

Lectotype: s/*Carpinus betulus*?, Bois du Casino de Charbonnières, Cne de La Tour de Salvagny (Rhône), 7bre 1933, M. Josserand, PC, selected by Bertault (1970); isolectotype in CUP 61933. (Specimen is also holotype of *Helminthosporium josserandii*.)

Type locality: Rhône, France.

Habitat: On decorticated wood of *Carpinus betulus*? [in Grelet's publication (1950), he describes the host as on decorticated decomposed trunk of *"quercûs, carpini vel fraxini*?"], *Ulmus americana*, on twig of undetermined host.

Distribution: France, U.S.A. (incl. Puerto Rico).

Exsiccatae specimens examined: None.

Other specimens examined: UNITED STATES: **New York:** On Dutch elm-killed *Ulmus americana* L., 5 Burhans Pl., Delmar, Town of Bethlehem, Albany Co., Oct. 18, 1977, John H. Haines, J.H.H. 3260, NYS (as *Strossmayeria basitricha* with *Pseudospiropes simplex*). **Puerto Rico:** Trail from km. 12.2 to Falls of Rio de La Mina, El Yunque, elev. 650 m., June 8, 1970, R.P. Korf, leader, et al., CUP-PR 3929.

Illustrations: Grelet, L. J., *Rev. Mycol. (Paris)* **15:** 39, Fig. 31, 1950; Bertault, *Rev. Mycol. (Paris)* **35:** 135, Fig. 1, 1970; this paper, Fig. 6g, 21.

Etymology: The epithet *josserandii* is in honor of the collector, Prof. M. Josserand.

Notes: This species can be distinguished from *S. basitricha* by conidial elements: shape and size, presence of the torus, dark basal cell, and apical beak. It can also be distinguished by the difference in sizes of the ascospores, the measurements of *S. basitricha* being considerably smaller. It can be distinguished from *S. bakeriana* in the same conidial characteristics and in the mature apothecial shape.

Bertault (1970) indicated that he studied two syntype collections made by Josserand, one collected on September 29, 1933, and the second collected on October 7, 1933, both from the same station, an undetermined trunk surrounded by *Quercus, Fraxinus,* and *Carpinus*. Bertault selected the first one collected as the lectotype. We have not studied the lecto-paratype.

Collection CUP-PR 3929 bears two different *Strossmayeria* and *Pseudospiropes* species, *Strossmayeria dickorfii* and *Strossmayeria josserandii,* occurring mixed together on the same piece of wood. The part of this collection with *Strossmayeria josserandii* varies some from that of the other two collections of *S. josserandii* examined in having larger ascospores, ascospores which disarticulate, and larger, 9-septate conidia, with a basal scar 3.8 µm wide. In comparison the HT has a basal

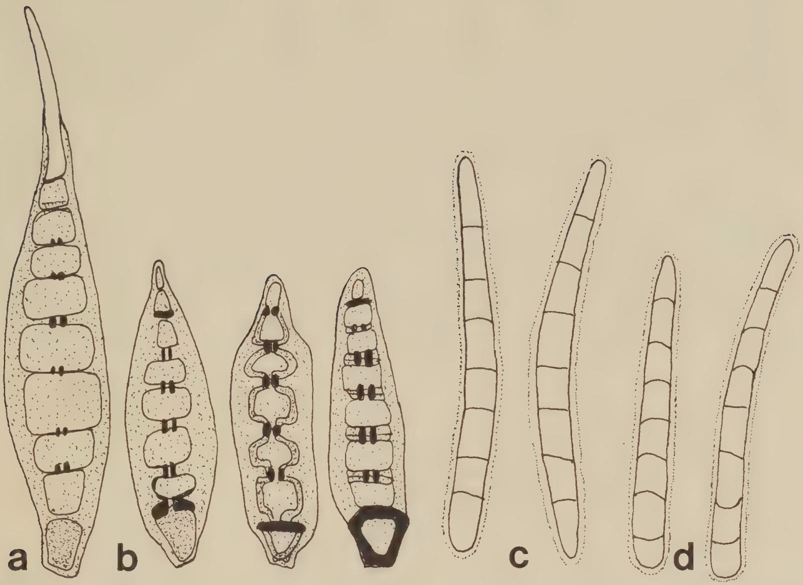


Figure 21. ***Strossmayeria josserandii.*** **a, b,** conidia; **c, d,** ascospores. **a, d,** CUP-PR 3929; **b, c,** HT. All × 1000.

scar 2.9 µm wide and 5-7-septate conidia, while in J.H.H. 3260 the basal scar is 2.6 µm wide, and the conidia are 7-septate. Conidia of CUP-PR 3929 have a longer beak, which may be a germination tube. The beak was not included in conidial measurements The reason for including CUP-PR 3929 in *Strossmayeria josserandii* is because of the presence of the torus in the conidia, and apothecial shape and color similarities. The torus is a unique character in the conidia of *Pseudospiropes josserandii,* and we believe that it deserves being considered as a diagnostic species character. The torus is not present in every conidium.

13. ***Strossmayeria nigra*** Iturriaga, *sp. nov.* (Fig. 22).

Ab Strossmayeriae *speciebus aliis apotheciis valde atris discoideis margine involuto striato praeditis, ascis parvis 71-94 × 13 µm differt.*

Anamorph: Unknown, presumably *Pseudospiropes* sp.

Apothecia discoid with an involute margin that is slightly striate and occasionally broken into slits, sub-stipitate, receptacle all black or dark brown, disc dark brown, reviving paler. Ectal excipulum of textura porrecta, 7.3-11 μm wide, dark brown, J+ reaction unobservable because of dark color of the excipulum, cells 8.8-14 (-16) × 2.2-3.7 μm. Medullary excipulum indistinguishable. Subhymenium of mainly textura globulosa mixed with textura intricata. Asci clavate, small, (66-) 71-94 (-103) × (11–) 13 (-15) μm, thick walled, walls 0.7-1.5 μm thick. Ascospores cylindrical-clavate, hyaline, J+, biseriate to triseriate, (26-) 29-36 × 3.7 (-4.4) μm, always 7-septate, gel sheath smooth and thin, less than 0.7 μm thick. Paraphyses very thin and filiform, simple, septate, sometimes remaining cylindrical, other times widening at the apex in a clavate shape, 0.7-1.5 μm wide in the middle, 1.5-3.7 μm wide at the apex. No anamorph found.

Holotype: On beech, near River Chocorea, N. H., Sept. 1916 (as *Patellaria* sp., then annotated by M. A. Sherwood in 1979 as *Strossmayeria* sp.). [Probably R. Thaxter, leg.], F.

Type locality: New Hampshire, U. S. A.

Habitat: On decorticated wood of *Fagus*.

Distribution: Only known from the HT.

Exsiccatae specimens examined: None.

Other specimens examined: None.

Illustrations: Fig. 22 in this paper.

Etymology: The epithet *nigra* is from the Latin, meaning black.

Notes: The main features of this species are the black or almost black apothecia, the very small asci and ascospores, and the presence of two different kinds of paraphyses. There was no trace of an anamorph on the only known collection. The name of the collector does not appear on the specimen, but from the collecting date and locality it was probably collected by Thaxter. This species may be distinguished from *S. atriseda* by ampler asci and wider ascospores. It may be distinguished from the rest of the species mainly because of the color and shape of the apothecia and because of its small asci and ascospores.

14. ***Strossmayeria notabilis*** Iturriaga, *sp. nov.* (Fig. 2a, 3b-c, 3f, 4j, 6i, 23).

Ab Strossmayeriae *speciebus aliis ascis longioribus latioribusque, 110-163 × 15-21 μm, et ascosporis longioribus 49-64 μm longis differt.*

Anamorph: *Pseudospiropes* sp.

Apothecia turbinate with a small point of attachment, 0.5-0.8 mm in diameter, usually gregarious to confluent, seldom scattered, upper flanks of receptacle white, pale, light brown or brown, lower flanks of receptacle and base brown, disc granulose, generally concolorous with upper receptacle, in one case lighter in color, base of the apothecia composed of roundish to irregular cells. Ectal excipulum usually of textura oblita with long parallel cells, J+, (7.0-) 9.0-17 × (1.5-) 2.0-4.0 µm. Asci generally saccate or at least with a short pedicel and blunt base, in a few cases with a long stipe and then having a clavate shape, (99-) 110-163 (-178) × (11-) 15-21 (-24) µm arising from croziers. Ascospores cylindrical-clavate, hyaline, J+, frequently with disintegrating cells, sometimes with crystal-like contents in the guttules of certain cells, triseriate, (31-) 49-64 (-77) × 4.0-6.0 (-7.0) µm, 7 (-9)-septate, most spores with a smooth gel sheath, some spores with a verrucose gel sheath, 1.0-2.0 µm thick. Paraphyses long and filiform, simple or divided, widening at the top, 1.5-2.2 (-3.7) µm at the middle, 2.9-3.7 (-5.9) µm at the top. Conidiophores brown, straight, with marked percurrent growth of the conidiophore, generally smooth, base swollen, (4.4-) 5.1-9.5 µm at the middle, 7.3-15 µm at the base. Conidia brown, of different shapes: obclavate and widening at the base, or obclavate with a central constriction, fusiform to fusiform with one flat side, (42-) 51-58 (-90) × (7.3-) 13-15 (-21) µm, basal scar width (2.9-) 4.4 (-5.1) µm, (6-) 7-10-septate.

Holotype: On bamboo, Casita Alta, [Prov. Chiriquí], 21 August 1937, G. W. Martin 4338, ISC ex IA 380549, Fungi of Panama, (Det. E. K. Cash as *Belonium sordidum*); isotypes in BPI [on trail between Boquete and summit of El Volcán. Alt. 2000-2200 m.] and CUP 61865 [slide].

Paratypes: INDONESIA: On rotting stem of *Amomum coccineum*, Tjibodas, Java, 22. XII. 1961, M. A. Rifai & R. P. Korf, CUP-SA 393.

PANAMA: On fallen palm trunk, Barro Colorado Id., Canal Zone, July 18, 1945. G. W. Martin 6067, (Det. E. K. Cash as *Belonium sordidum*) BPI, ISC ex IA 380550.

VENEZUELA: On dead herbaceous stems, path leading to water source behind the hotel, Rancho Grande, Aragua, June 14, 1968, K. P. Dumont, CUP-VE 4336.

Type locality: Panama.

Habitat: On bamboo, on decorticated wood of unknown host, on fallen palm trunk, on dead herbaceous stem, on rotting stem of *Amomum coccineum*.

Distribution: Indonesia, Panama, Venezuela.

Exsiccatae specimens examined: None.

Other specimens examined: None.

Illustrations: This paper, Fig. 2a, 3b-c, 3f, 4j, 6i, 23.

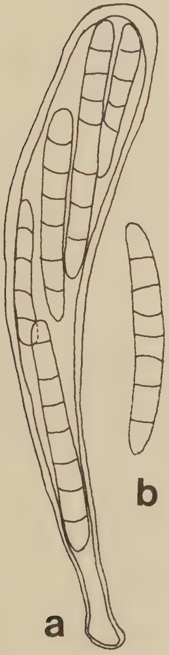


Figure 22. *Strossmayeria nigra* (HT). **a**, ascus with ascospores; **b**, ascospore. Both × 1000.

Etymology: The epithet *notabilis* is from the Latin, meaning remarkable.

Notes: The distinguishing characteristics of this species are the width of the asci, the width and length of ascospores, and the presence of refractocells in the ascospores. The ascospore gel sheath may be smooth or verrucose.

In the holotype the conidiophores are sparse and scattered but homogeneously distributed on the host, which is bamboo. This is a characteristic that we have observed for all species of *Strossmayeria* when they occur on bamboo.

In the Venezuelan collection the ectal excipular cells are narrower than any of the other collections of this species, 1.5-2.2 µm wide, and the apothecia arise from dark brown melanized round patches on the host.

In the Panama collection Martin 6067 the ectal excipulum is between textura porrecta and textura oblita, which is unusual, since this tissue in all other species of *Strossmayeria* is of textura oblita.

The collection from Iowa State University 380550 (ex Martin 6067) has two different *Strossmayeria* species: *S. confluens* (Seaver) Iturriaga & Korf (on the large piece of wood), and *S. panamaensis* (on the small piece of wood).

The Java collection differs from the other collections because it has saccate asci, verrucose ascospore gel sheath, and absence of refractocells or disintegrating cells in the ascospores.

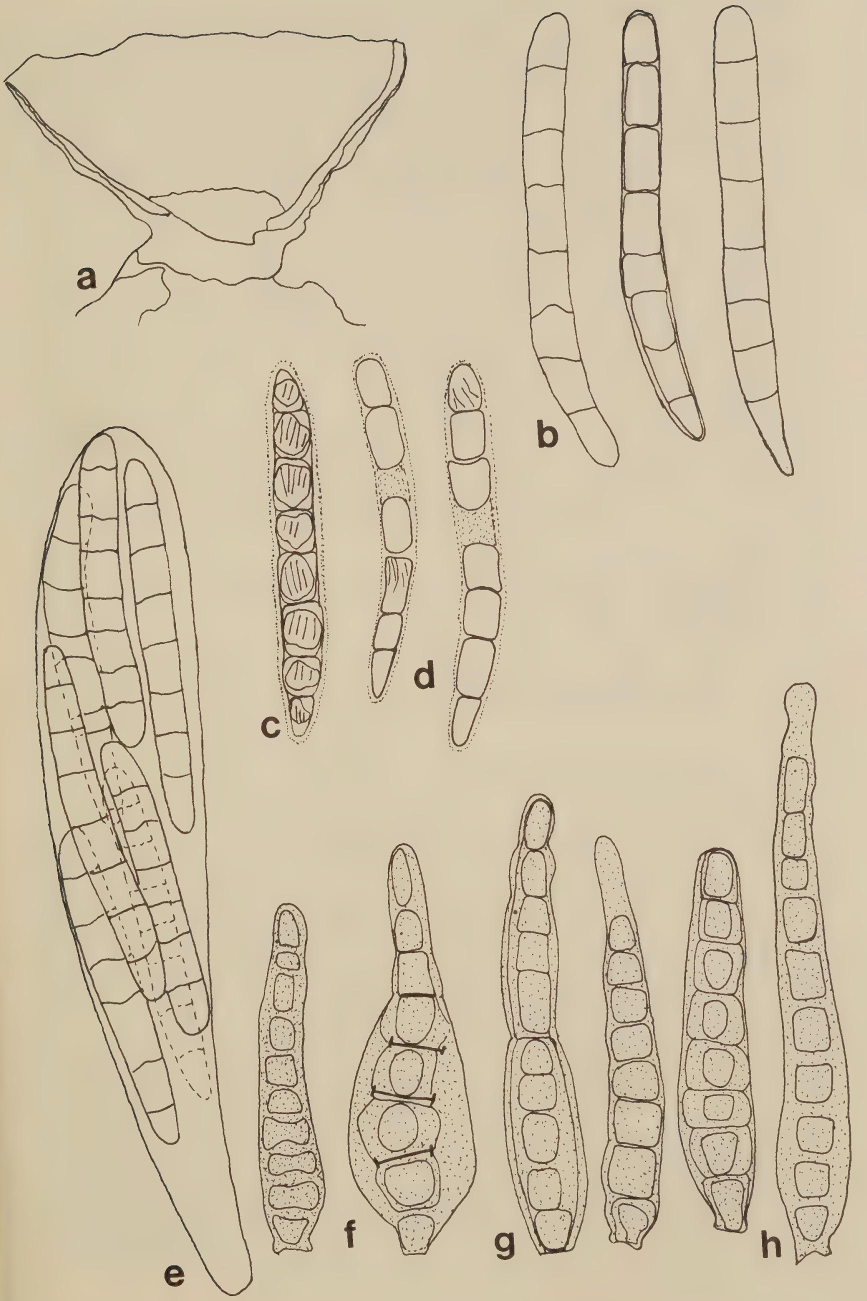
15. ***Strossmayeria ochrospora*** Iturriaga, *sp. nov.* (Fig. 24a-c).

Ab Strossmayeriae *speciebus aliis ascosporis parietibus flavo-brunneis et septis flavo-brunneis praeditis differt.*

Anamorph: *Pseudospiropes* sp.

Apothecia 0.8-1.0 mm in diameter, turbinate when young, shallow cupulate when mature, receptacle dark brown, lighter toward the edge, disc reviving pale to light brown, medium to dark brown when dry. Ectal excipulum of textura oblita, outer layers dark brown, inner layers light brown and J+, cells 7.0-10 × 1.0–3.0 µm. Asci 8-spored, clavate, when young with an apical papilla, 150-178 (-185) × (13–) 15–17 µm. Ascospores cylindrical clavate, outer walls and septa light yellow-brown in all or some of the cells, J+, disintegrating cells or refractocells sometimes present, triseriate, (33-) 44-56 × 4.0-5.0 µm, (6-) 7 (-8) septate, septa distinctly light brown, gel sheath slightly verrucose. Paraphyses long and filiform, simple, septate, frequently swollen and rounded at the apex, 2.0

Figure 23. ***Strossmayeria notabilis.*** **a,** median section of apothecium; **b-d,** ascospores; **e,** ascus with ascospores; **f-h,** conidia. **a, b, f, h,** HT; **c, g,** Martin 4338, BPI; **d, e,** Martin 6067, BPI. **a,** × 100; all others × 1000.


a
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µm wide at the middle, 3.0 µm wide at the apex. Conidiophore brown, lighter toward the apex, septate, flexuous, with scars that do not protrude grossly, 5.0-7.0 µm wide at the middle, 8.8 µm wide at the base. Conidia fusiform, brown, 7-septate, dark septa absent, sometimes with central and/or basal cells dark, 36-37 × 11–12 µm, basal scar 2.0-3.0 µm wide.

Holotype: On dead stem of *Rhipogonium scandens* (= 'Supplejack'), Orongorongo Valley, near Wellington, New Zealand, November 1970, A. Bell, NY - Fungi of New Zealand, CUP 61932 ex NY.

Paratype: AFRICA: [Ruwenzori, 6600 ft.], Scott Elliot [no date], CUP-D 4166 (73-75) ex NY-Massee.

Type locality: Near Wellington, New Zealand.

Habitat: On dead stem of *Rhipogonium scandens,* and on old bark.

Distribution: New Zealand and Africa (Uganda).

Exsiccatae specimens examined: None.

Other specimens examined: None.

Illustrations: This paper, Fig. 24a-c.

Etymology: The epithet *ochrospora* is from the Latin, referring to the colored ascospores.

Notes: Diagnostic characters for this species are the light brown ascospores with brown lateral walls and septa and the brown receptacle.

16. ***Strossmayeria sordida*** (Cash) Iturriaga, *comb. nov.* (Fig. 4g, 6h, 24d-h).

≡ *Belonium sordidum* Cash, *Iowa Studies Nat. Hist.* **17:** 215. 1937. (!!)

≡ *Pseudohelotium sordidum* (Cash) Dennis, *Kew Bull.* **1954:** 317. 1954.

Anamorph: *Pseudospiropes* sp.

Apothecia turbinate, up to 1 mm diameter, scattered or gregarious, usually confluent, upper receptacle usually light brown but sometimes white when rehydrated, generally brown toward the base, seldom remaining light in color, disc concolorous with upper receptacle or lighter in color. Ectal excipulum of textura oblita, formed by long rectangular cells with thickened gelatinized walls, cells (5.9-) 10-18 × 2.2-2.9 µm. Medullary excipulum and subhymenium not distinguishable. Asci 8-spored, generally clavate, seldom saccate, and if so, clavate asci in the same apothecium, (99-) 114-140 (-155) × (9.4-) 13-17 (-19). Ascospores cylindrical-clavate, rarely subfusoid, hyaline, J+, with uniform cells, with refractocells present and frequently guttules occurring in the refractocells with the refractive elements, multiseriate, (33-) 37-48 (-60) × (3.7-) 4.4-5.8 µm, 6-7 (-8)-septate, gel sheath smooth, 1.0-1.5 µm thick. Paraphyses long and filiform, simple or divided, swollen at the apex in a clavate shape, 0.7-1.5 µm at the middle, 2.0-3.7 µm at the apex. Conidiophores brown, flexuous, sometimes scars not protruding so evidently, others protruding as

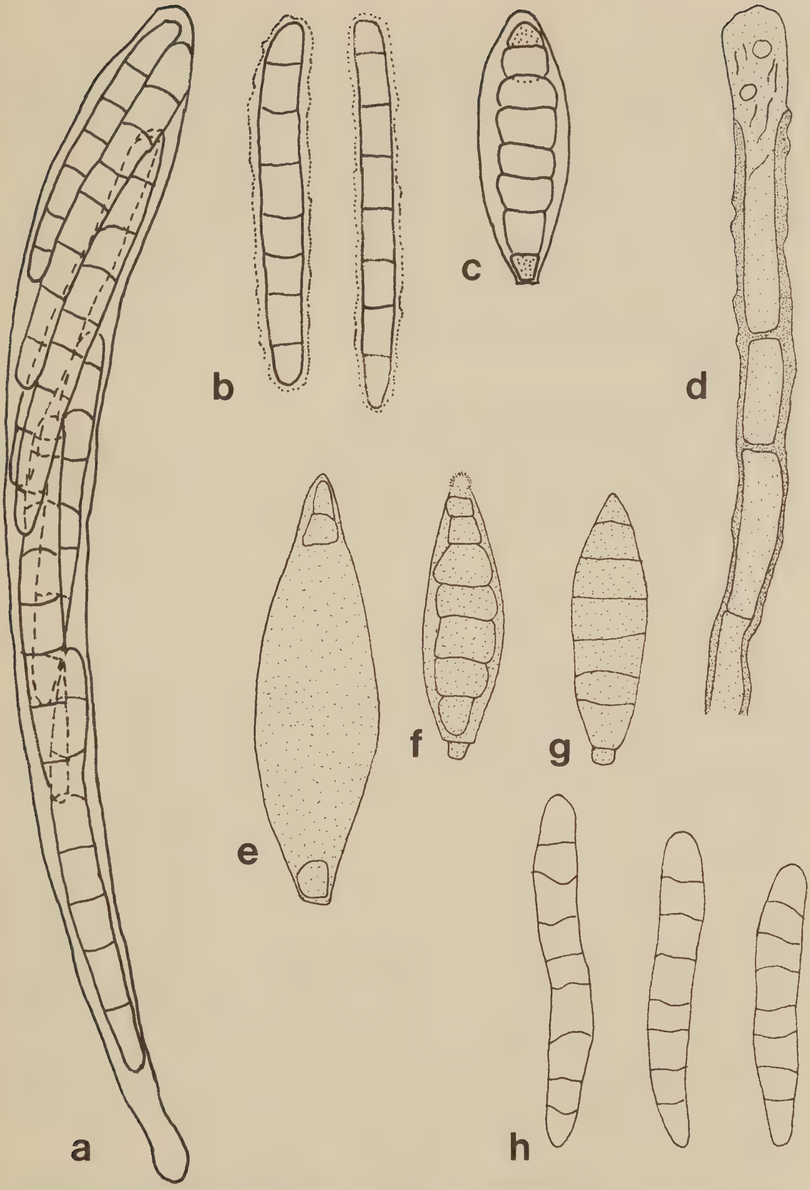

Figure 24. ***Strossmayeria*** **spp. a-c,** ***S. ochrospora*** (HT). **a,** ascus with ascospores; **b,** ascospores; **c,** conidium. All × 1000. **d-h,** ***S. sordida.*** **d,** conidiophore; **e-g,** conidia; **h,** ascospores. **d, f,** Isolectotype, IA 380551; **e, g, h,** HT. All × 1000.

much as 0.7 μm from the conidiophore, 6.6-10 μm wide at the middle, base swollen 9.5-13 μm wide. Conidia fusiform usually with a pedicel-like cell, dark cells absent, dark septa usually absent, but if present the basal and extreme septa are the darker ones, (26-) 31-44 (-50) × (6.6) 8.1-12 (–13) μm, basal scar 2.2-3.7 μm, 6-7 (-8)-septate.

Lectotype: (Selected here.) Prov. Coclé: Valle Chiquita, about 7 k. south of El Valle de Antón. Alt. 500-600 m., July 25, 1935, G. W. Martin 3008, Fungi of Panama [on decorticated wood] (as *Belonium sordidum*), BPI (isolectotypes in BPI ex MO 162188, ISC ex IA 380551, CUP 61867 [slide]).

Type locality: Prov. Coclé, Panama.

Habitat: on decorticated wood of unknown host, on *Sabal bermudiana*.

Distribution: Bermuda, Panama.

Exsiccatae specimens examined: None.

Other specimens examined: BERMUDA: On *Sabal bermudiana,* Paget Marsh, Jan. 29, 1922, H. H. Whetzel, CUP 35006, R.P.K. 1187.

Illustrations: Cash, E. K., *Univ. Iowa Stud. in Nat. Hist.* **17:** Pl. 14, fig. 3, 1937; Dennis, R. W. G., *Kew Bull.* **1954:** fig. 28, p. 318; this paper, Fig. 4g, 6h, 24d-h.

Etymology: The epithet *sordida* is from the Latin, meaning dirty.

Notes: There are three collections marked “Martin No. 3008”, all of them labeled “Type” or “Part of Type.” The number given in the original description is Martin 3008, but there is no mention of a particular portion as the holotype. Therefore, we selected a lectotype amongst the three portions of the collection, the other two becoming isolectotypes.

In the original publication Cash (1937) says: “A complete set of these collections is in the herbarium of the State University of Iowa, Iowa City, and duplicates of most of them have also been deposited in the Mycological collections of the Bureau of Plant Industry, Washington” (now BPI). Apparently this meant that the holotype (HT) was the specimen deposited at Iowa, but indeed there should have been a clearer designation of which portion was the HT where collection No. 3008 was mentioned. This lack of clarity in the HT designation and the fact that the Iowa collection (No. 380551) no longer has any apothecia, made me choose as the LT one of the two portions that has both states, anamorph and teleomorph. We designate the BPI portion as the LT because in that packet a copy of the original published description was included, indicating that possibly Cash gave that packet a special importance over the others. The pieces of wood of the three portions that bear the number 3008 fit together like a puzzle, so one can be sure that they really are parts of the same collection.

Our measurements of the asci differ from those of Dennis (ours are larger), and agree with Cash’s. We did not observe the moniliform cells at the apex of the paraphyses that Dennis (1954) described.

Dennis (1954) transferred *Belonium sordidum* to the genus *Pseudohelotium,* indicating that “in coloring, stature, habit and structure it agrees well with *Peziza pineti* Batsch, the type species of *Pseudohelotium*." Dennis (1968) commented on the similarities between *Pseudohelotium pineti* and *Gorgoniceps aridula:* "It will be seen that there is little difference between this and *Pseudohelotium* apart from the number of septa in the ascospores ...." These comments and dispositions seem to indicate that Dennis's concepts of *Gorgoniceps, Pseudohelotium,* and *Strossmayeria* were not clear. Neither Cash nor Dennis described the presence of the anamorph on the specimen of *Belonium sordidum.* If Dennis had observed the anamorph he would surely have included it in the genus *Strossmayeria*, as he did with three other species, *S. phaeocarpa* (Dennis, 1960), *S. sphenospora* (Dennis, 1962), and *S. viridi-atra* (Dennis, 1962), included in that genus partly because hyphomycetes were present with them.

S. sordida may be distinguished from *S. jamaicensis* in that *S. sordida* has uniform, not enlarged refractocells, smooth usually thick gel sheath in the ascospores, conidial basal scar width of 2-4 µm, and usually larger conidia.

Cash (1937) described this species as *Belonium sordidum.* Her concept of the genus *Belonium* was clearly far wider than that adopted by modern taxonomists.

6. EXCLUDED SPECIES

Species correctly assigned to the genus *Strossmayeria* have been assigned by various authors to other genera because of sharing similar characters. At other times they have been assigned to such genera by mistake, due to lack of information or due to unclear or too broad generic delimitations. Some of the genera under which *Strossmayeria* species were found were *Belonidium, Belonium, Gorgoniceps, Hyaloderma, Lecanidion, Leptobelonium,* and *Peziza.* Descriptions of the species recorded under these genera were studied in order to decide which of them could be possible *Strossmayeriae,* and thus had to be studied.

Of the seven species that have been previously assigned to the genus *Strossmayeria,* three were previously excluded: *S. viridi-atra* (Sacc. & Fautr.) Dennis, *S. sphenospora* (Kirscht.) Dennis, and *S. phaeocarpa* Dennis (Iturriaga, 1984). None of these three is a member of the genus *Strossmayeria* as delimited here. One of the three species which Iturriaga (1984a) accepted in the genus, *S. longispora,* has been placed in synonymy with *S. bakeriana,* above.

7. SPECIES IMPERFECTLY KNOWN

1. *Belonidium albo-cereum* Penz. & Sacc., *Malpighia* **15:** 215. 1902 ('1901').

Holotype: ad ligna putrida, Tjibodas (7 ex parte).

Illustration: Penzig, O. & P. A. Saccardo. 1904. *Icones Fungorum Javanicorum,* Tab. LIV, Fig. 1.

Notes: We asked for this specimen in different herbaria: F, BO, and PAD. Apparently it is not at F or BO. We were not able to get a response from PAD in regard to this specimen.

According to von Höhnel (1923) this species is a synonym of *Leptobelonium helminthicola* (Blox.) Höhn. [*i.e.,* of *Strossmayeria basitricha* (Sacc.) Dennis].

2. [*Belonium flocculum* Kirchstein *in* Schieferdecker, *Z. Mus. Hildesheim,* n. ser., **7:** 87. 1954 (not validly published).]

'Holotype': April/May 1943, Hildesheim, Weidengebüsch bei der Drei-Bogen-Brücke, auf der Innenseite abblätternder Weidenrinde.

Illustration: *l.c.,* Taf. 13, d.

Notes: The name *B. flocculum* Kirchstein is not validly published (no Latin diagnosis). We considered it to be worth studying, even though the description is very short, due to ascospore characters: cylindrical shape, 3-septate, eventually 4-septate, colorless. We wrote B (Dahlem) for the specimen, but it was not there, so we were unable to examine it.

3. *Belonidium fructigenum* P. Henn. & E. Nym. *in* Warburg, *Monsunia* **1:** 31. 1900.

Holotype: Java, Hort. Bogor.: auf faulenden Früchten von *Cedrela serrulata,* 26 März 1898. (E. Nyman).

Notes: No illustration is provided with the original description. We tried to obtain this specimen from B (Dahlem) and BO (Indonesia). It is not in those herbaria. According to von Höhnel (1923) this species is a later synonym of *Leptobelonium helminthicola* (Blox.) Höhn. [i.e., of *Strossmayeria basitricha* (Sacc.) Dennis].

4. *Belonidium glauco-fuligineum* Penz. et Sacc., *Malpighia* **15:** 214. 1902 ('1901').

Holotype: in vaginis foliorum putrescentium Palmarum in horto Bogor, 22. XII. 1896 (75).

Illustration: Penzig, O. and P. A. Saccardo, *Icones Fung. Javanic.,* Tab. LIII, Fig. 4. 1904.

Notes: The specimen was asked for in several herbaria: BO, PAD and F. It is not housed in F. The two first herbaria did not answer.

5. *Belonidium guttula* Rick, *Brotéria* **5:** 36. 1906.

Holotype: In mycelio fusco perisporiaceo, ramos bambusinos occupante. Rio Grande do Sul, Brasiliae.

Notes: We wrote PACA (Anchieta), but did not receive an answer or the specimen. Judging by the description this species may be a *Strossmayeria.*

Rick's original publication (1906) was followed (1932: 41, 42) by a publication in which he again described the same species, twice, due to a mistake.

6. *Belonidium japonicum* Hara [as *Belanidium,* lapsus calami], *A list of Japanese Fungi hitherto known,* p. 399. 1954.
Holotype: In *Pinus pentaphyllus* var. *Himekomatsu*, in Japonica. Tokyo: in Komaba, K. Hara, Jan. 10. 1911.
Notes: This is a doubtful species. Nevertheless, since some characters of the description could match *Strossmayeria* characters, we wrote to Japan, but the specimen is apparently lost. The main characters of this species are: yellow apothecia and 3-septate ascospores, constricted at the septa, 22-25 × 4.0-5.0 µm.

7. [*Gorgoniceps kirschsteinii* Jaap, *Verh. Bot. Vereins Prov. Brandenburg* **64:** 14. 1922. (*'Kirschsteinii'*) *nomen nudum* (no description).]
'Holotype': Auf alten Harzgallen an *Pinus silvestris* mehrfach.
Notes: See *Gorgoniceps kirschsteniana,* below.

8. *Gorgoniceps kirschsteniana* Jaap *ex* Kirschst., *Ann. Mycol.* **36:** 378. 1938.
Holotype: Triglitz, Ostprignitz. Auf einem dürren Ast von *Pinus silvestris* an Harzgallen und Apothecien von *Biatorina difformis*, Oktober 1912, O. Jaap.
Notes: The HT of *G. kirschsteniana* Jaap is apparently lost. The type specimen was requested as a loan from several herbaria, B, FH, and HBG. It was not found. This is probably a respelling of *G. kirschsteinii* Jaap.

9. *Belonidium pulvinatum* Boud., *Bull. Soc. Myc. France* **12:** 14. 1896.
Holotype: Ad basim culmorum putridorum *Junci capitati* in paludosis sylvae, Montmorency, Martio 1895 (PC).
Notes: We were unable to study this species. Judging by the description it may be a *Gorgoniceps* or belong to a closely related genus. Boudier says it differs from *Gorgoniceps* in the shorter asci and non-filiform ascospores.

10. *Belonidium rathenowianum* P. Henn. & Ploettn., *Verh. Bot. Vereins Prov. Brandenburg* **41:** 97. 1899.
Holotype: Rathenower Stadtforst auf Eichenholz vereinzelt mit *Ceratosphaeria quercina,* 30 März 1899. (B-Dahlem)
Notes: We received no answer from this herbarium, so were unable to study the specimen.

11. *Belonium sulphureo-testaceum* v. Höhn., *Ann. Mycol.* **3:** 553. 1905. (!!)
≡ *Leptobelonium sulphureo-testaceum* (v. Höhn.) v. Höhn., *Ber. Deutsch. Bot. Ges.* **37:** 108. 1919.
Holotype: Allentsteig, 9. 1905, No. Waldviertel, v. Höhnel (F) .

Notes: We were unable to find an apothecium that matched the description. The collection includes soil and sand, making it difficult to detect tiny apothecia. To judge by the description, this species seems similar to *Strossmayeria sphenospora* (Kirschst.) Dennis, which the senior author excluded from the genus (Iturriaga, 1984).

12. *Belonidium tabacinum* Penz. et Sacc., *Malpighia* **15:** 214. 1902 ('1901').

Holotype: in ramis corticatis, emortuis, Goenoeng Pantjar, Raciborski.

Notes: We wrote PAD and also wrote to BO, but received no answer. The description suggests it could belong to *Strossmayeria.*

13. *Gorgoniceps taveliana* Rehm *in* Rabenh., *Krypt.-Flora* **1**(3): 691. 1892. (!!)

Holotype: In den Spalten abgefellener Föhrenrinde auf der Coerhaide bei Münster i. W. (v. Tavel), S-Rehm.

Notes: This seems to be a species of the genus *Gorgoniceps,* but the part of the HT that we received was not sufficient for full determination. It could be a *Strossmayeria.*

14. *Gorgoniceps verniicola* (P. Henn.) Batista, *Atas Inst. Mic. Univ. Recife* **1:** 244. 1960.

≡ *Erinella verniicola* P. Henn., *Hedwigia* **43:** 272. 1904. (!!)

Holotype: Perú, Tarapoto: Auf Blättern von *Vernonia* spec., Dezember 1902, No. 3185, F.

Notes: We could not find any fungus on the portion of the HT that was sent to us.

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NOMENCLATURE AND SYNONYMY OF STEREUM SPADICEUM VAR. PLICATUM

by

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There is much confusion regarding the nomenclature and synonymy of *Stereum spadiceum* var. *plicatum* Peck.

Stevenson and Cash (1936) cited:
Stereum spadiceum var. *plicatulum* Peck Rept. N.Y. State Mus., 50 : 132, 1897
= *Stereum plicatulum* (Peck) Lloyd Myc. Writings 7 : 1157, 1922

A check of the Peck (1998) publication shows that the name published there was *Stereum spadiceum* var. *plicatum* and not *plicatulum* as has been mentioned by Stevenson and Cash in 1936.

Lentz (1955) cited :
Stereum spadiceum var. *plicatum* Peck N.Y. State Mus. Ann. Rept., 50 : 132, 1897.
= *Stereum plicatum* (Peck) Lloyd Mycol Notes [Writ.] 7, Mycol Notes 67 : 1157, 1922, ut *plicatulum*, lacking Pk. publication data.

However, from the above two lists of synonymy and forgoing discussion one might conclude that :
Stereum spadiceum var. *plicatum* Peck Rept. N.Y. State Mus., 50 : 132, 1897
= *Stereum plicatum* (Peck) Lloyd Mycol Notes [Writ.] 7, Mycol Notes 67 : 1157, 1922
= *Stereum plicatulum* (Peck) Lloyd Myc. Writings 7 : 1157,1922

But both Stevenson and Cash (1936) and Lentz (1955) made some mistakes.

The authority of both *Stereum plicatum* (Lentz 1955 p. 52) and *Stereum plicatulum* (Stevenson and Cash 1936) have been wrongly cited as '(Peck) Lloyd'. Authority of both of these taxa should be cited simply as 'Lloyd' (Lloyd 1918 p 807 and Lloyd 1922 p.1157 respectively).

Secondly, the reference to *Stereum plicatum* has been wrongly represented by Lentz (1955). The correct citation should be : 'Mycol. Writ. 5, (Mycol Notes 56) : 807, 1918' (Lloyd 1918 p. 807).

Thirdly, consideration of *Stereum spadiceum* var. *plicatum* [Stevenson and Cash [1936] cited 'var. *plicatulum*' by mistate] as synonymous with *Stereum plicatum* (Lentz 1955) and *Stereum plicatulum* (Stevenson and Cash 1936) is erroneous.

Stereum spadiceum var. *plicatum* was published by Peck (1898) based on a fungus collected from New York State, U.S.A.; *Stereum plicatum* was published by Lloyd (1918) as a new species based on a fungus collected from Sydney, Australia; *Stereum plicatulum* was published by Lloyd (1922) based on a fungus collected from Sendai, Japan.

A review of literature (Peck, 1898, Lloyd 1918, 1922) and the foregoing discussion reveals that *Stereum spadiceum* var. *plicatum* Peck, *Stereum plicatum* Lloyd and *Stereum plicatulum* Lloyd are three distinct taxa, as they have been validly published based on three different type materials, each of which differs from the other two in many importat and distinctive features.

American mycologists have seemingly been unable to distinguish between *Stereum spadiceum* var. *spadiceum* and *S. spadiceum* var. *plicatum* and the latter name is now usually cited in synonymy under *S. spadiceum*. In contrast *S. plicatulum* as represented by the Japanese material sent to Lloyd by Prof. A. Yasuda and also by recent material collected in India appears to provide a name for an otherwise undescribed Asiatic *Stereum*.

ACKNOWLEDGEMENTS

The author is greatly indebted to Dr. R.P.Korf (USA) and Dr.D.A.Reid (Kew, England) for critically reviewing the manuscript.

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PHOMA PROBOSCIS SP. NOV. PATHOGENIC ON CONVOLVULUS ARVENSIS

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ABSTRACT

Phoma proboscis Heiny pathogenic on field bindweed (*Convolvulus arvensis* L.) is described and illustrated. *P. proboscis* is typified by rostrate pycnidia, eguttulate, occasionally septate conidia averaging 10.5 x 3.5 μm, unicellular, spherical chlamydospores, and optimal growth at 20°C.

INTRODUCTION

Diseased field bindweed (*Convolvulus arvensis* L.) leaves and stems were collected in Phillips County, Colorado, in 1988 and transported to Arkansas under permit from the USDA Animal and Plant Health Inspection Service and the Arkansas State Plant Board. A species of *Phoma* was isolated from diseased plant tissue and reinoculated on field bindweed seedlings in a growth chamber. The fungus caused collapse of young petioles and shoots and development of small lesions on leaves. Severe infection below the cotyledonary node caused death of field bindweed seedlings.

Several species of *Phoma* have been described previously from *Convolvulus* spp. or the related genus *Calystegia* without regard to their pathogenicity.

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Included among these are *Phoma convolvuli* Wehmeyer on *Convolvulus glomerata* Chois. collected in India (Wehmeyer, 1964); *Phoma sepium* Brun. on *Calystegia sepium* (L.) R. Br. (Saccardo, 1895); *Phoma minuta* Alcalde and *Phoma macrocollum* Alcalde on *Calystegia sepium* in Spain (Alcalde, 1952). Saccardo (1895) also listed *Phoma capsularum* (Schw.) Starb. in seed capsules of *Convolvulus purpureus* (syn. *Ipomoea purpurea* (L.) Roth.) (Bedevian, 1936). The Colorado field bindweed isolate, described here as a new species, combines characteristics that do not occur together in any previously described species of *Phoma* (Boerema, 1976; Boerema et al., 1965; Boerema et al., 1981; Dorenbosch, 1970; Morgan-Jones, 1988a; Morgan-Jones, 1988b; Morgan-Jones and White, 1983; Sutton, 1980; Wehmeyer, 1946; Wehmeyer, 1964).

MATERIALS AND METHODS

Colony characteristics and radial growth rates of mass transfer cultures were determined on each of four media incubated at 20, 25, or 30°C in darkness [Table 1]. Agar disks 5 mm in diameter were taken from 7-day-old potato dextrose agar (PDA) spread plate cultures and inverted in the center of each plate. All treatments were replicated four times. Measurements of radial growth were recorded after 4, 7, and 14 days. Dimensions of 10 pycnidia and 15 conidia were measured from each medium after 14 days of growth at 25°C, exposed to a 12-hr daily photoperiod 42 cm from the light source (Bright Stik, General Electric, Cleveland, Ohio 44112).

Agar blocks (2 cm square) of cultures from each medium were exposed to ammonia vapors or treated with 1 N NaOH for observation of pigment change or crystal formation diagnostic for some *Phoma* species (Dorenbosch, 1970).

Pycnidia from PDA were fixed in Karnovsky's fixative (1965), embedded in JB-4 resin (Polysciences, Inc., Warrington, PA 18976-2590), and sectioned 4 to 10 μm thick with a glass knife on a Sorvall MT2-B Ultra-microtome. Sections were stained with Lugol's iodine (Tuite,1969; Boerema et al., 1981) or 3% erythrosin in 10% ammonia (Sutton, 1980) for permanent resin mounting, or wet-mounted in lactophenol cotton blue containing 0.004% aniline blue (EM Diagnostic Systems, Inc., Gibbstown, New Jersey 08027).

DIAGNOSIS

Phoma proboscis sp. nov.

Laesiones circulares vel elongato-irregulares, usque ad 2 mm diametro, coalescentes et laesiones grandiores formantes, cinereae vel fulvidae vel aurantiaco-brunneae, margine distincto, brunneo, deducentes caules juvenes et petiolos hospitis illuc ut hi collabentur et desiccescantur. Mycelium septatum, ramosum, pallide brunneum vel brunneum, hyphis 4.5-7 µm latis. Pycnidia solitaria vel confluentia, subglobosa vel ampulliformia, brunnea vel atrobrunnea, ex parte immersa vel superficialia, pro parte maxima glabra, pseudoparenchymata, ostiolis solitariis vel plus (usque ad 9) praedita, colla elongata aliquando ramosa solitaria vel plus plerumque confingentia. Pycnidia 173-550 X 112-275 µm (383 X 256 µm), collo 1/3- 3-plo longiore quam pycnidii diametro. Cellulae conidiogenae phyialidicae, hyalinae, simplices, parietibus laevibus praeditae, subglobosae vel late ampulliformes, 6.5-9.0 X 6.5-12.5 µm. Conidia salmonea (in congerie), enteroblastica, hyalina, simplicia, juventute eguttulata, ex culturis vetustioribus biguttulata, cylindrica vel anguste ellipsoidea, extremitate una saepe parum ampliora, pediformia vel interdum parum curvata, utraque extremitate obtusa, laevia, continua (vel ea maxima aliquando 1-septata), 5.5-15.0 (17) X 2.3-5.0 µm, medio numero 10.5 X 3.5 µm. Chlamydosporae sphericae, unicellulares, intercalares, ca. 14 µm diametro.

Lesions circular to elongate irregular, up to 2 mm in diameter, coalescing to form larger lesions, gray or tan to orange-brown, margin distinct, brown; causing young stems and petioles to collapse and desiccate. Mycelium septate, branched, pale brown to brown with hyphae 4.5-7 µm wide. Pycnidia solitary or confluent, subglobose to flask-shaped, brown to blackish brown, partly immersed or superficial, mostly glabrous, pseudoparenchymatous, with one or more ostioles (up to nine), usually developing one or more elongate necks, which sometimes branch. Pycnidia 173-550 X 112-275 µm (383 X 256 µm) with neck length from 1/3 to 3 times the diameter of the pycnidium. Conidiogenous cells phialidic, hyaline, simple, smooth-walled, subglobose to broadly flask-shaped, 6.5-9.0 X 6.5-12.5 µm. Conidia salmon color in mass,

enteroblastic, hyaline, simple, eguttulate when young, biguttulate from older cultures, cylindrical or narrowly ellipsoidal, often slightly larger at one end, foot-shaped or sometimes slightly curved, obtuse at each end, smooth, continuous or largest conidia occasionally one-septate, 5.5-15.0 (17) X 2.3-5.0 μm, averaging 10.5 X 3.5 μm. Chlamydospores spherical, unicellular, intercalary, approximately 14 μm in diameter.

P. proboscis differs from other species in having rostrate pycnidia, relatively large eguttulate conidia that are occasionally septate, unicellular, spherical chlamydospores, and an optimum growth rate at cooler temperatures (20°C).

Figure 1; Plates 1, 2, 3 and 4.

Pycnidia developed on dead tissue following incubation under lights in a moist chamber [Plate 1, A, B].

Growth rates varied with media and temperature [Table 1]. The highest rate of growth occurred on oatmeal agar at 20° C. At 25°C, rate of development was greater on oatmeal agar than on any other medium. No growth occurred in darkness at 30°C on any medium [Table 1].

Colonies on malt extract agar (MEA) were dark

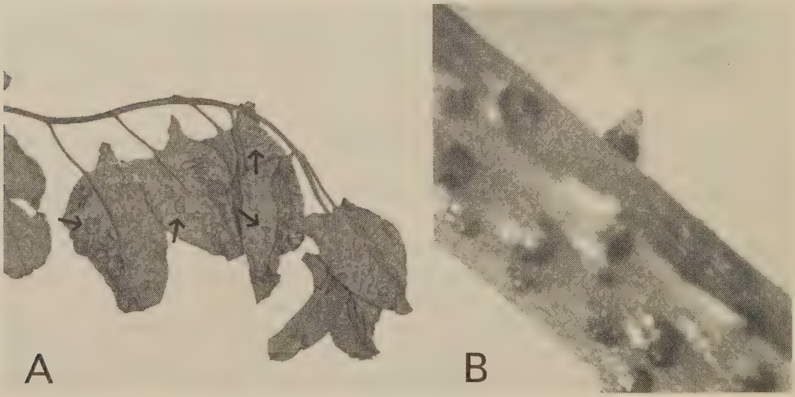


PLATE 1. A, Lesions on leaves and stems of *Convolvulus arvensis* caused by *Phoma proboscis* (selected lesions indicated by arrows). B, Pycnidia of *P. proboscis* developing on bindweed stem.

Table 1

Average growth diameter of *Phoma proboscis* plated on various media at three temperatures.[a]

	Potato Dextrose Agar[b]			Malt Extract Agar[c]			Oatmeal Agar[c]			Cellulose Agar[d]		
Days[e]	20°C (mm)	25°C (mm)	30°C (mm)	20°C (mm)	25°C (mm)	30°C (mm)	20°C (mm)	25°C (mm)	30°C (mm)	20°C (mm)	25°C (mm)	30°C (mm)
4	15.0	7.0	5.0	11.5	7.5	5.0	15.0	12.0	5.0	13.0	6.5	5.0
7	29.0	7.0	5.0	24.0	7.5	5.0	34.0	12.5	5.0	21.0	7.0	5.0
14	57.0	7.0	5.0	46.0	8.0	5.0	70.0	17.5	5.0	43.0	7.0	5.0

[a] A culture plug 5 mm in diameter was inverted on four replications of each of four media. Plates were incubated in darkness at the temperatures indicated.

[b] Acidified (Difco Laboratories, Detroit, MI 48232).

[c] Difco Laboratories, Detroit, MI 48232.

[d] Eggins and Pugh (1962), substituting cellulose powder MN 300 by Macherey, Nagel & Co. (Brinkmann Instruments, Inc., Westbury, NY 11590) for ball-milled Whatman's cotton cellulose powder.

[e] Number of days plates were incubated.

olivaceous with sparse aerial mycelium [Plate 2, A], with center darker and thinly floccose or slightly ropy in appearance, reverse dark olivaceous. On PDA colonies were lanose or somewhat floccose, yellow-brown to dark brown, pigment increasing with age, with a white margin 5 mm wide, colony darker towards the center, reverse brownish [Plate 2, B]. No pycnidia developed in darkness on MEA or PDA.

Colonies on cellulose agar in darkness had some aerial mycelium, becoming floccose with age, producing sparse pycnidia after 7 days at 20°C, fewer at 25°C. Mycelium was sparse and brown in agar [Plate 2, C]. On oatmeal agar, colonies were dark brown, consisting of a dense mat of pycnidia even in darkness, with a 6-mm-wide, light brown, lanose margin. Aerial mycelium was sparse, increasing with age, floccose to lanose, olive-brown or gray to white in color [Plate 2, D].

Mycelium was composed of septate, branched, pale brown to brown, short (9.0 X 7.0 μm) or long (20.5 X 4.5 μm) barrel-shaped or straight cells 13.5-36.5 X 4.5-5.5 μm [Plate 3, A, B]. Chlamydospores developed in hyphae on malt extract agar, less frequently on cellulose agar or PDA [Plate 3, C, D].

HOLOTYPE: On leaf petioles and blades, and on stems of *Convolvulus arvensis* L.; Phillips County, Colorado, U.S.A., May, 1988, D. K. Heiny, UARK.

PARATYPES: BPI, K.

LIVING CULTURES: ATCC.

Etymology of specific epithet: Refers to elongate necks of pycnidia that sometimes resemble an elephant's trunk.

ADDITIONAL NOTES

Ammonia vapor did not cause crystallization or changes in color of agar or hyphae. NaOH caused no change on MEA or PDA, but marginal hyphae on oatmeal agar turned light orange-brown, darkening beyond the yellowing of oatmeal agar alone treated with NaOH. No crystals were produced on any medium.

Exposure to light promoted pycnidia development on all media. Pycnidia developed elongate necks within 7 days on all media, especially on PDA [Plate 3, G-K; Plate

4, A-F]. Pycnidia sometimes produced branches that developed into an enlargement resembling a pycnidium [Plate 4, F]. Pycnidia were smallest on cellulose agar, 102-428 X 102-193 μm, averaging 246 X 134 μm. Otherwise, 173-550 X 112-275 μm, averaging 383 X 256 μm.

The pycnidial wall was composed of textura angularis [Plate 3, E], with two to five layers [Plate 3, F], 13-18 μm thick, frequently slightly thicker in the zone of transition between the neck and the main pycnidia body [Plate 4, A, D], with individual cells 7-16 μm in diameter. Cells darkened upon addition of Lugol's iodine,

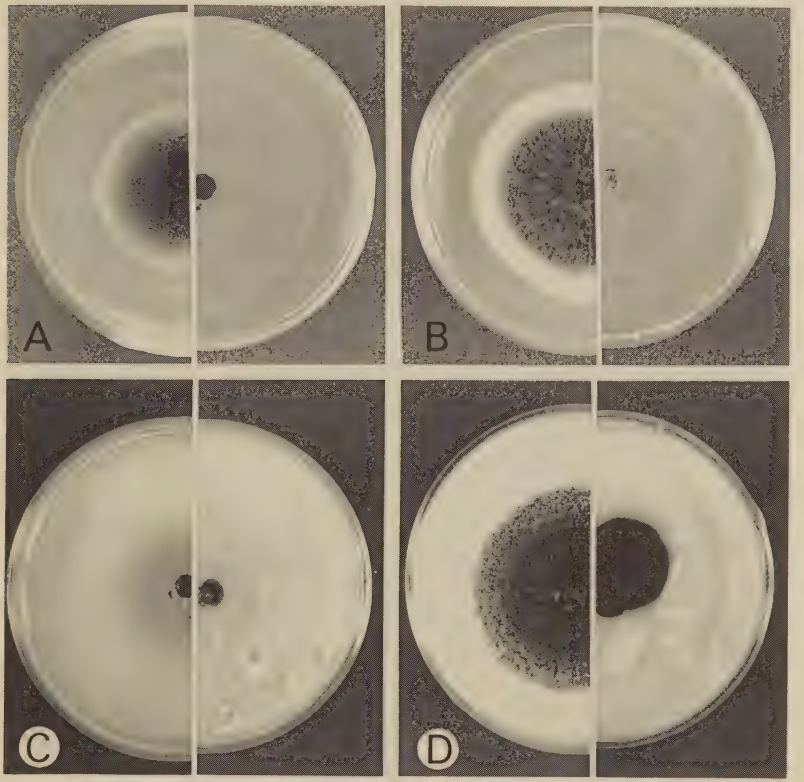


PLATE 2. Growth of *Phoma proboscis* on various media after 14 days in darkness at 20 C (left) and 25 C (right). A, malt extract agar; B, potato dextrose agar; C, cellulose agar; D, oatmeal agar.

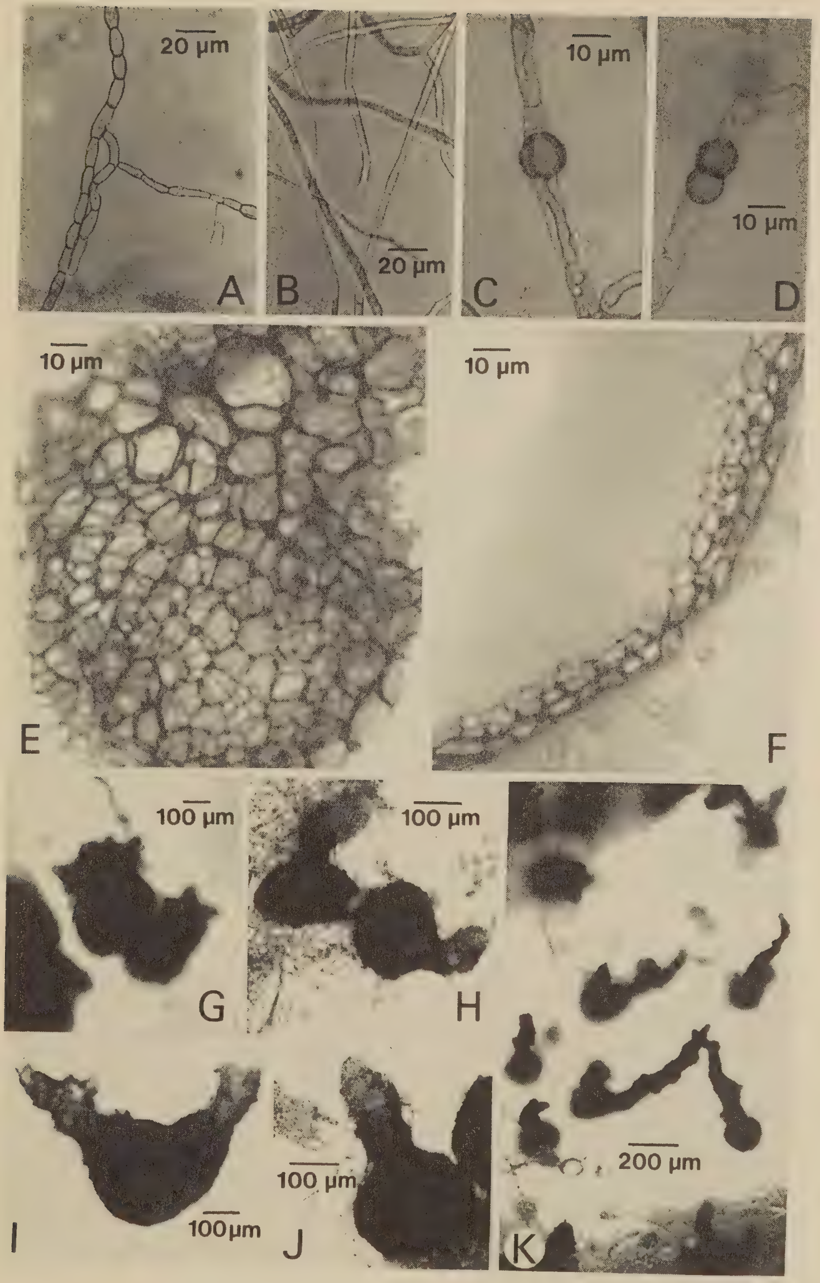
which is brown, but did not turn red as described by Boerema et al. (1981) for scleroplectenchyma of some *Phoma* species in the section *Plenodomus*. Conidiogenous cells were borne on the innermost cells of the pycnidial wall up to the base of the neck region. Conidia were as described previously [Plate 4, G]. Concentrated spore suspensions appeared muddy brown. Conidia on water agar initially produced a single germ tube through one end or laterally near one end of the spore [Plate 4, H].

DISCUSSION

The isolate was compared to an isolate of *Phoma complanata* (Tode ex Fries) Desmazieres obtained from the American Type Culture Collection (ATCC #32158). Conidia of *P. complanata* had a size range similar to the range of *P. proboscis*, and some conidia had one septum. However, the majority of *P. complanata* conidia were found to be smaller (7.0 X 3.0 μm) than conidia of *Phoma proboscis*, pycnidia were much smaller (153 X 125 μm), and, other than temperature and light preferences, no similarities in other cultural or morphological characteristics were found. Other *Phoma* species that produce occasional septate conidia include *P. dennisii* Boerema (Boerema, 1976), *P. exigua* Desm. var. *exigua* (Morgan-Jones and Burch, 1988c), *P. lycopersici* Cooke (Morgan-Jones and Burch, 1988b), *P. macrostoma* Montagne (White and Morgan-Jones, 1984), *P. medicaginis* Malbr. & Roum. (Boerema, 1976; Morgan-Jones and Burch, 1987), and *P. pinodella* (L.K. Jones) Morgan-Jones & Burch (Boerema, 1976; Morgan-Jones and Burch, 1987; White and Morgan-Jones, 1987).

P. minuta and *P. macrocollum* on *Calystegia sepium* have conidia sizes of 2-3.4 X 0.9-1.2 μm and 2.8-4.2 X

PLATE 3. Mycelium, chlamydospores, and pycnidia of *Phoma proboscis* developing on artificial media. A, hyphae with barrel-shaped cells; B, hyphae composed of straight cells; C, spherical, single-celled, intercalary chlamydospore; D, chlamydospores; E, pycnidial wall; F, cross-section of pycnidial wall; G, multiostiolate pycnidia from oatmeal agar; H, pycnidia from potato dextrose agar; I, pycnidium with two necks from potato dextrose agar; J, pycnidium from potato dextrose agar; K, pycnidia with elongate necks on potato dextrose agar.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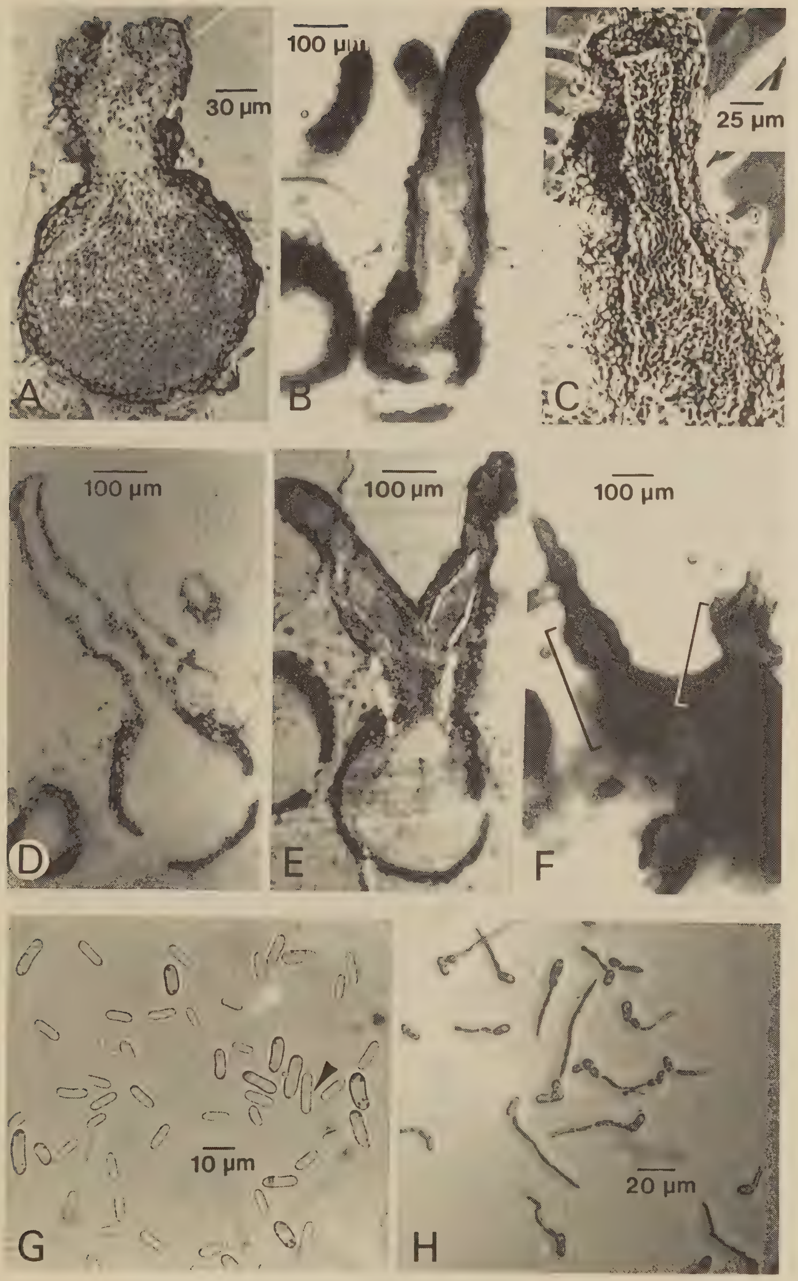
1.5-2.0 μm, respectively (Alcalde, 1952). Both ranges are completely outside the range for *P. proboscis*. Spore sizes of *P. sepium* from *C. sepium* are 10-12 X 4 μm, but pycnidia are described without measurements as sparse and minute (Saccardo, 1895), which is not typical of *P. proboscis*. *P. convolvuli* from *Convolvulus glomerata* has fusoid conidia 6-7 X 1.5-2.0 μm (Wehmeyer, 1964), too small for *P. proboscis*. *P. capsularum* from *Ipomoea purpurea* (tall morningglory) has conidia approaching the appropriate size for *P. proboscis* (8-10 X 2.5-3.5 μm), but details on shape and guttulation of conidia are not available (Saccardo, 1883; Saccardo, 1895). Pycnidia of *P. capsularum* on average are smaller than expected for *P. proboscis* and lack a pronounced rostrum (Saccardo, 1883; Saccardo, 1895). *P. capsularum* is apparently restricted to the seed capsules of tall morningglory.

Like *Phoma proboscis*, the type species for the genus, *Phoma herbarum* Westend., is described as having salmon pink spores (Boerema, 1964). Among other differences, however, *Phoma herbarum* produces a red pigment that changes to violet-blue upon addition of NaOH (Dorenbosch, 1970). The shapes of pycnidia of *Phoma proboscis* are similar to the shapes of pycnidia of *Phoma multirostrata* (Mathur, Menon & Thirum.) Dorenbosch & Boerema (Dorenbosch & Boerema, 1973; Dorenbosch and Höweler, 1968). However, conidia of *P. multirostrata* measure 5-6.5 X 2-2.5 μm, and cultures grow rapidly at 30°C (Dorenbosch and Boerema, 1973), unlike cultures of *P. proboscis*, which grow better at cooler temperatures (20°C; Table 1). Colonies of *P. multirostrata* attain diameters of 76 mm, 80 mm, and 72 mm after 7 days on PDA at 20°C, 25°C, and 30°C, respectively (Morgan-Jones, 1988b); *P. proboscis* requires 14 days on PDA to reach a diameter of 57 mm at 20°C, and grows very slowly at 25°C and 30°C on

PLATE 4. Pycnidia and conidia of *Phoma proboscis*. A, longitudinal-section of short-necked pycnidium; B, longitudinal-section of pycnidium with elongate neck; C, longitudinal-section of neck of pycnidium; D, longitudinal-section of pycnidium with elongate neck; E, longitudinal-section of pycnidium with branching neck; F, enlargements on pycnidia bearing one neck (left) or several necks (right); G, conidia (arrowhead indicates septum); H, germinating conidia on water agar, stained with lactophenol cotton blue.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all media tested [Table 1; Plate 2]. The structures of the pycnidial walls of *P. proboscis* and *P. multirostrata* also differ. The outer cells of pycnidial walls of *P. proboscis* are distinctly isodiametric. In *P. multirostrata* they are ellipsoid or oblong to cylindrical (Morgan-Jones, 1988b). Pycnidia of *P. proboscis* are not covered by a loose network of hyphae, a characteristic that distinguishes this species from *P. multirostrata* (Morgan-Jones, 1988b), *P. herbarum* (Morgan-Jones, 1988a), and *P. americana* Morgan-Jones & White (Morgan-Jones and White, 1983). The unicellular chlamydospores of *P. proboscis* are more spherical than chlamydospores of *P. multirostrata*, which are doliiform, oblong, or flat-sided (Morgan-Jones, 1988b). Only three additional genera with unicellular chlamydospores have been described: *P. pinodella* (Boerema, 1976; White and Morgan-Jones, 1987), *P. eupyrena* Sacc. (Morgan-Jones and Burch, 1988a), and *P. medicaginis* (Morgan-Jones and Burch, 1987).

Species belonging to *Phoma* section *Plenodomus* (Preuss) Boerema, van Kesteren & Loerakker (1981) have rostrate pycnidia. *P. proboscis* is not included in section *Plenodomus* because it does not produce a thick or scleroplectenchymatous pycnidial wall like other members of the section.

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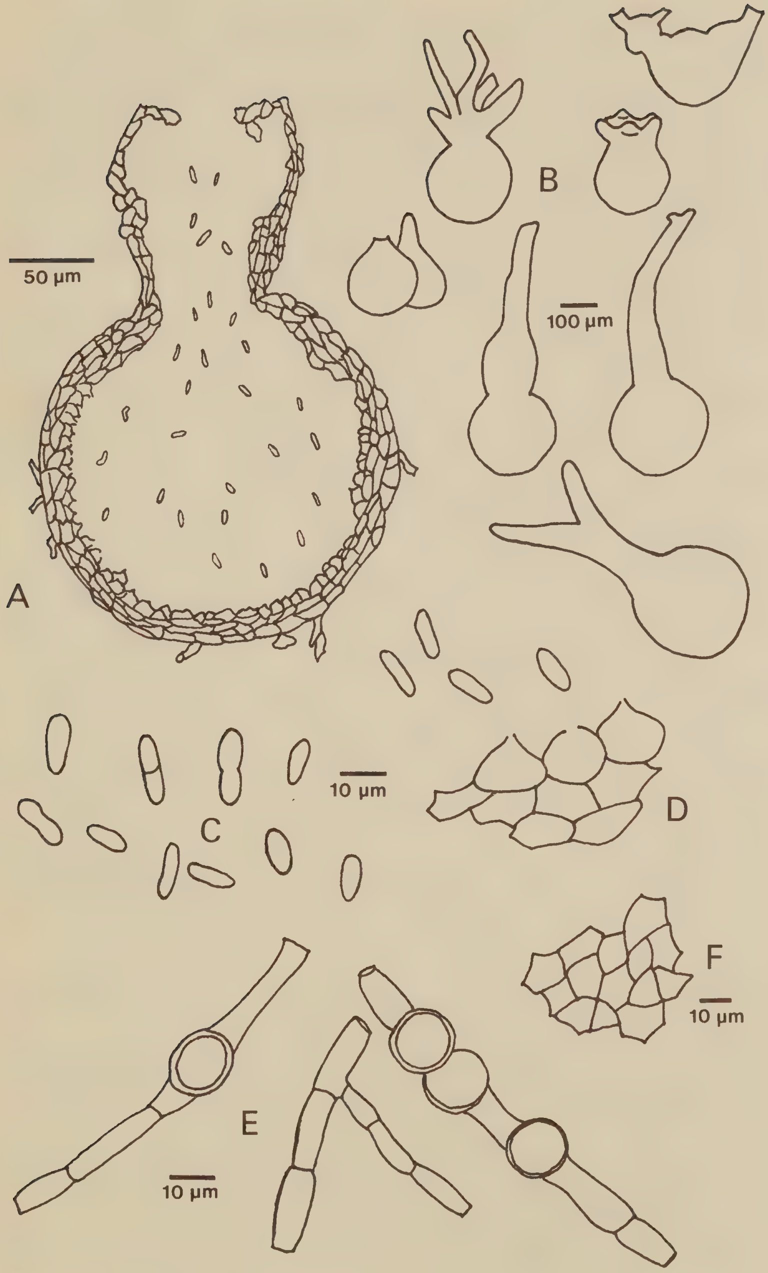
FIGURE 1. *Phoma proboscis*. A, longitudinal-section of pycnidium; B, various forms of pycnidia; C, conidia; D, conidiogenous cells; E, hyphae and chlamydospores; F, portion of pycnidial wall.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TAXONOMICAL STUDIES ON USTILAGINALES. V.*

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ABSTRACT

NEW SPECIES proposed: Entyloma zacintha Vánky (type on Crepis zacintha). – Melanotaenium antirrhini Viennot-Bourgin ex Vánky (type on Antirrhinum latifolium). – Ustilago dumosa Vánky & Oberwinkler (type on Rumex dumosus).

The following names are considered SYNONYMS: Entyloma crepidis Kaw.-Starm. (type on Crepis praemorsa = misidentified Hieracium sp.) is E. hieracii H. & P. Sydow ex Cif., s. str. – Melanotaenium lamii Beer (type on Lamium album), and M. koschurnikoveanum Lavrov (type on Galeopsis tetrahit) are synonyms of M. jaapii P. Magnus (type on Teucrium montanum). – Neovossia iowensis Hume & Hodson, and N. danubialis T. Savul. (both having types on Phragmites australis) are considered synonyms of Neovossia moliniae (Thümen) Körn. (type on Molinia coerulea). – Uredo digitariae Rabenh. (type on Digitaria sp. = misidentified Cynodon dactylon) is Ustilago cynodontis (P. Henn.) P. Henn. – Ustilago cariciphila Speg. (type on Carex bonariensis) is Farysia thuemenii (Fischer v. Waldh.) Nannf.

EXCLUDED SPECIES: Entyloma aristolochiae Saccardo (type on Aristolochia elegans) represents immature ascocarps of a pyrenomycete. – Entyloma debonianum Saccardo (type on Oenanthe globulosa), and Entyloma hydrophilum Saccardo & Paoletti (type on Sium cicutaefolium) are probably Protomycetales. – Entyloma erodianum Saccardo (type on Erodium moschatum) is not a fungus but granules of an unidentified substance. – Entyloma glyceriae Fragoso (type on Puccinellia festuciformis subsp. tenuifolia) is Physoderma gerhardtii (Chytridiales). – The type of Entyloma xanthii Massalongo (on Xanthium strumarium) contains only necrotic host cells. – Melanotaenium byzovae Schwarzman (type on Galium tenuissimum) is a myxomycete.

LECTOTYPE is selected for Tilletia wilcoxiana Griff. (= T. hyalospora Massee).

In this paper, further results of my taxonomical and nomenclatorial investigations on smut fungi are presented.

Entyloma species on Crepis s. lat. (Compositae).

The following Entyloma species were described from different Crepis species:

1) E. crepidicola Trotter, 1908:21, type on Crepis bulbosa (L.) Tausch (= Aetheorhiza bulbosa (L.) Cass.), Italy, Avellino, S. Agata di Sopra, 14.V.1907, A. Trotter (Urophlyctis crepidicola Trotter, 1907:27; nomen nudum). Sori as globose outgrowths on the roots, 4–5 mm in diameter. Spores in groups, first

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* Studies in Heterobasidiomycetes, part 72

intracellularly, globose, ellipsoidal, sometimes slightly angular, mostly 13–15 µm in diameter, when young yellowish, when mature chestnut brown. Spore wall often irregular, 1.5–2.5 µm thick, smooth. Known only from the type locality. (Material not seen, description taken from the original.)

2) *E. crepidis-rubrae* (Jaap) Liro, 1938:139, type on *Crepis rubra* L., Yugoslavia, Dalmatia, Monte Marian near Spalato, 22.V.1914, O. Jaap (BPI 175176!). Sori as discoidal or convexo-concave, callous spots on the leaves, 1–3 mm in diameter, grayish or yellowish-brown. Spores (Fig. 1) usually adhering in irregular groups, globose, broadly ellipsoidal or polyhedral, 9–15 x 12–18(–20) µm, orange-yellow or light brownish-yellow. Spore wall smooth, two-layered, uneven, 1.5–3.5 µm, sometimes with a short, pedicel-like thickening at the angle. It was reported on different *Crepis* species from Europe and Asia.

3) *Entyloma crepidis* Kawecka-Starmachowa, 1939:173, type on "*Crepis praemorsa*", USSR, Ukraine, Kolomyya (formerly Poland, Kolomya, Bania Berezowska, Mt. Rokieta), VI.1913, A. Wróblewski (as *Entyloma calendulae*; KRAM 2521!). Kochman & Majewski (1973:178) considered *E. crepidis* as a synonym of *E. picridis*, together with *E. arnoseridis*, *E. leontodontis* and *E. hieracii*. The restudy of the type specimen, a leaf from KRAM, showed that the host plant actually does not belong to *Crepis praemorsa* (L.) Tausch but it is a *Hieracium* sp. (from the group *murorum*; checked also by Professor W. Sauer), and the smut is identical to *E. hieracii* H. & P. Sydow ex Ciferri, s. str.

4) A further *Entyloma* species on various *Crepis* species is not identical to either *E. crepidicola* or *E. crepidis-rubrae*. Its formal description is the following:

Entyloma zacintha Vánky, sp. nov.

Typus in matrice *Crepis zacintha* (L.) Babcock (= *Lapsana zacintha* L. = *Zacintha verrucosa* Gaertner), Graecia, ins. Rhodos, inter pagg. Agaia Isodoros et Laerma, alt. ca. 200 m.s.m., 27.IV.1978, K. Vánky. Holotypus in herbario HUV (7174!); isotypus in BPI.

Sori in foliis maculas rotundas, amphigenas, dispersas vel gregarias, 0,5–2 mm diam., primum albidas deinde flavas et postremam pallide brunneas formantes. Sporae singulares vel in gregibus parvis congregatae, globosae, ovoideae vel plusminusve irregulares, 10–15 x 13–19 µm diam., subhyalinae vel flavido-brunneae, pariete bistratoso, strato interno cca. 0,5 µm crasso, strato externo saepe inaequaliter incrassato, 1,5–4(–5) µm crasso, levi. Anamorpha ignota.

Sori (Fig. 7) in leaves as round, thin, amphigenous, scattered or gregarious spots, 0.5–2 mm in diameter, first whitish, then yellow and finally light brown. Spores (Fig. 2) solitary or in small groups, globose, ovoid or more or less irregular, 10–15 x 13–19 µm in diameter, subhyaline to pale yellowish-brown; wall two-layered, the inner layer c. 0.5 µm thick, the outer layer often unevenly thickened, 1.5–4(–5) µm wide, smooth. Anamorph not seen.

Key to the *Entyloma* species on *Crepis* s. lat.

1. Sori as globose outgrowths on the roots . . . . *E. crepidicola*
– Sori as leaf-spots 2
2. Sori callous. Spores in groups. Spore wall up to 3.5 µm thick *E. crepidis-rubrae*
– Sori not callous. Spores solitary or in small groups. Spore wall up to
5 µm thick . . . . *E. zacinthae*

Melanotaenium species on Scrophulariaceae.

Viennot-Bourgin (1956:38) described (invalidly; ICBN Art. 35.1 & 36.1) *Melanotaenium antirrhini* on *Antirrhinum*, collected in France. The study of the type specimen, compared with the two other *Melanotaenium* species, known on Scrophulariaceae, *M. cingens* (G. Beck) P. Magnus, and *M. hypogaeum* (L.-R. & C. Tulasne) Schellenberg, showed that *M. antirrhini* is a distinct species. Its description is the following:

Melanotaenium antirrhini Viennot-Bourgin ex Vánky, sp. nov.
Typus in matrice Antirrhinum latifolium Miller, Gallia, Distr. Alpes Maritimes, Andon, pr. Grasse, VI.1954, leg. Bouscary (PC!).

Sori in parte basali caulium pustulas molybdeas usque nigrescentes, saepe confluentes et magnas partes caulium nonnunquam ascendentes usque ad inflorescentiam surculis basalibus foliisque non exceptis obtegentes, primum epidermide tectas serius epidermide rupto, massam nigram agglutinatam sporarum ostendentes formantes. Sporae globosae, subglobosae, ellipsoideae, nonnunquam parum compressae, nunquam angulares, 12–18 x 14–20 µm, atrorubrobrunneae, granulis plenae, pariete levi, 2-stratoso, plusminusve aequaliter incrassato, 1,5–2,5 µm crasso, sine maculis refractivis.

Sori on basal part of stems as lead-coloured to blackish pustules, often confluent and covering large parts of the stems ascending sometimes to the inflorescence, and comprising basal shoots and leaves, first covered by the epidermis which later ruptures disclosing the black, agglutinated spore mass. Spores (Fig. 4) globose, subglobose, ellipsoidal, sometimes slightly flattened, never angular, 12–18 x 14–20 µm, dark reddish-brown, with granular contents; wall smooth, two-layered, more or less evenly thickened, 1.5–2.5 µm wide, no light-refractive spots.

The main differences between the three species of Melanotaenium on Scrophulariaceae are presented in form of a key.

1. Sori as large galls on the hypocotyls. On Kickxia . . . . M. hypogaeum
– Sori as pustules on the stems and leaves 2
2. Spores usually irregular, often angular, 16–24 µm long; wall uneven, 1–4 µm wide, light-refractive spots often present. On Linaria . . . . M. cingens
– Spores more or less regular, 14–20 µm long; wall even, 1.5–2.5 µm wide, light refractive spots absent. On Antirrhinum . . . . M. antirrhini

Discussion. For the spore measurements of Melanotaenium cingens, Viennot-Bourgin (1956:170) gives almost the same values (12–17 x 14–21 µm) as for his M. antirrhini (12–18.5 x 15–20 µm). For spore measurements of the type of M. cingens (on Linaria genistifolia, Austria, Mt. Leopoldsberg near Wien, VI.1880, G. Beck; HUV 1403; Fig. 3), I obtained 13–21 x 16–24 µm. Unfortunately, Viennot-Bourgin did not describe the spore wall, and he did not specify which sample he studied. If the host plant was correctly identified (as Linaria) it could mean that Linaria species may be parasited by both M. cingens and M. antirrhini. Actually, Viennot-Bourgin's figure (Pl. 42, fig. 1) of M. cingens represents a host plant with a tumour on the stem, which is not typical for M. cingens.

Melanotaenium species on Labiatae.

Three species of Melanotaenium were described on different Labiatae. Common to these species is, i.a., that the sori appear on the basal part of the stems or on the hypocotyl as swellings or tuberous bodies. M. jaapii and M. koschurnikoveanum are known only from the type collections while M. lamii was collected in a few localities in England and Germany. The comparison of the spores of these three species revealed no essential morphological differences. Consequently, I consider them as conspecific as follows:

Melanotaenium jaapii P. Magnus, 1911:456, type on Teucrium montanum L., Germany, Thuringia, near Jena, mt. Hausberg, 14.VII.1911, O. Jaap (PC!). – M. lamii Beer, 1920:337 (September), type on Lamium album L., Great Britain, England, Gloucestershire, Stroud, Chalfont, early summer 1918, W.F. Drew (K). – M. lamii H. & P. Sydow, 1920:156 (April 15, 1921; later homonym), type on L. album, Thuringia, Gross Furra near Sondershausen, 17.V.1918, G. Müller (JE). – M. koschurnikoveanum Lavrov, 1934:87, type on Galeopsis tetrahit L., USSR, W. Siberia, prov. Tomsk, near Baturino, 28.VII.1926, M.N. Koschurnikova (LE!).

Sori on underground stems and hypocotyl as swellings or tuberous bodies, from a few mm to several cm long, dark coloured, containing agglutinated, black spore masses. Spores subglobose, ovoid, usually irregular, subpolyhedral or flattened, sometimes with protuberances and also with light-refractive areas, 12–18 x 16–23 µm in diameter, dark reddish-brown; wall smooth, often two-layered and irregularly thickened, 1–2(–3.5) µm wide.

Neovossia moliniae, N. iowensis and N. danubialis = one species.

Neovossia moliniae (Thümen) Körnicke (1879:217), the type of the genus, is characterised by sori in scattered ovaries of Molinia caerulea (L.) Moench, and by ovoid to irregularly elongated, sometimes subglobose or lemon-shaped, finely and densely foveolate, dark reddish-brown spores, 12–20 x 17.5–32(–36) µm in diameter, provided with a long, hyaline appendage derived from the sporogenous hypha. Spore germination usually results in short basidia bearing a large number of terminal fusiform or slightly curved basidiospores which, without copulation, give rise to mycelia or short, falciform ballistospores (secondary sporidia).

Neovossia iowensis Hume & Hodson, in Hodson (1900:274) and N. danubialis T. Săvulescu (1955:71) were described from scattered ovaries of Phragmites communis Trin. (= P. australis (Cav.) Trin. ex Steudel). Although spores of N. danubialis were described as being larger than N. iowensis, I found that differences in the spore measurements fall within the normal variability of a species (Vánky 1985:95). I consider N. danubialis a synonym of N. iowensis.

While N. moliniae and N. iowensis are distinct from all other known Neovossia species, they are indistinguishable from one another, even in SEM pictures of the spores and germination studies. Consequently, I consider them as one species under the oldest name N. moliniae.

The types of Tilletia wilcoxiana Griff.

In the protologue of T. wilcoxiana, Griffiths (1904:88) mentioned two collections, both on "Stipa eminens Andersonii Vasey" (= S. lepida Hitchc. var. andersonii (Vasey) Hitchc.), from USA, California, Santa Monica, collected by H.E. Hasse. One of the samples was collected in "Spring 1901", the other in "April 1902". The second date, however, was probably a slip of the pen and should have been April 5, 1895. The original samples are preserved in Beltsville. The first one (BPI 173930!), is represented by scanty, more or less immature sori. The second one is richer (BPI 173929! & 173924!), labelled as "n. sp.", collected on "April 5, 1895". There is no collection from April 1902. I select as lectotype for Tilletia wilcoxiana Griff. that on Stipa lepida Hitchc. var. andersonii (Vasey) Hitchc., USA, Ca., Santa Monica, 5.IV.1895 (BPI 173930!), and as syntype that of spring 1901 (BPI 173930!). T. wilcoxiana is a synonym of T. hyalospora Massee (1899:148).

Ustilago cariciphila Speg. = Farysia thuemenii.

Spegazzini (1925:152) described U. cariciphila with some hesitation, under the genus Ustilago (type on Carex bonariensis Desf., Argentina, Prov. Buenos Aires; no special collection designated). Spegazzini characterised this species, i.a., by the following: sori in ovaries, spore mass olivaceous, powdery. Spores subglobose, 6–10 µm long, olivaceous; wall thin (1–1.5 µm), when young smooth, when mature finely papillate. Ciferri (1931:58), without seeing any material, transferred it into the genus Cintractia.

The study of a specimen, collected by C. Spegazzini in Argentina, Prov. Buenos Aires, Navarro, 13.V.1917 (LPS 3117!) revealed that it is Farysia thuemenii (Fischer v. Waldheim) Nannfeldt (F. olivacea (DC.) H. & P. Sydow). The sori start to develop from the floral pedicel, within the utricle, beneath the young nutlet (similar to F. thuemenii on Carex riparia – G. Deml, pers. comm.).

Spores very variable in shape and size, globose, subglobose (4–7 µm), irregular, pyriform or elongate (5–12 µm long), pale olivaceous-brown, densely verruculose. Hyphal fascicles ("elaters"), typical for *Farysia* are also present.

What is *Ustilago digitariae* auctt.?

Kunze (in Holl 1830:369) described *Uredo* (*Ustilago*) *digitariae* Kunze as follows: "maculis obsoletis pallidis, acervis germinum effusis, sporangiolis magnis, sporidiis globosis, minutissimis, atris. Auf *Digitaria setigera* Rth.", collected by F. Holl, Island of Madeira. From this short and incomplete description the fungus can not be identified with certainity. Regarding the host plant, Professor Scholz's opinion (in litt.) is: "Apparently the name *Digitaria setigera* Roth given by Kunze is a misidentification. Only one species of *Digitaria* is reported from Madeira: *D. ciliaris* (Retz.) Koeler".

Rabenhorst published in his exsiccata (Rbh., Herb. viv. myc. ed. 2, No. 1199, 1847) "*Uredo Digitariae* Rabenh. Mspt. Ab *Ured. Panicorum* W. sat diversa! *Digitariae* germina infestat, pr. Triest, Rabenh." This fungus, at least the HUV copy (no. 3622), is typical *Ustilago cynodontis* (P. Henn.) P. Henn. on misidentified *Cynodon dactylon* (L.) Pers.

Winter (in Rabenhorst 1881:88), based on Kunze's name, *Uredo digitariae* Kunze, but using Rabenhorst's material (= *Ustilago cynodontis*), gave a more detailed description of what he considered to be "*Ustilago digitariae* (Kunze) Winter".

Consequently, it is not known what the name *Uredo* (*Ustilago*) *digitariae* Kunze (1830) represents. On the other hand, *Uredo digitariae* Rabenh. (1847) is *Ustilago cynodontis* (P. Henn.) P. Henn. (1893) /syn. *Ustilago segetum* (Bulliard) Ditmar var. *cynodontis* P. Hennings (1892)/. That means, that for the well-known and wide-spread smut of *Cynodon dactylon* there is an older name than *Ustilago cynodontis* (P. Henn.) P. Henn., namely *Uredo digitariae* Rabenh. Fortunately, Kunze's fungus *Ustilago digitariae* (Kunze) Winter (1881) preoccupies the name *Ustilago digitariae* and it is not necessary to propose the Henningean name for conservation, at least until the identity of Kunze's fungus can be clarified by the study of the type specimen.

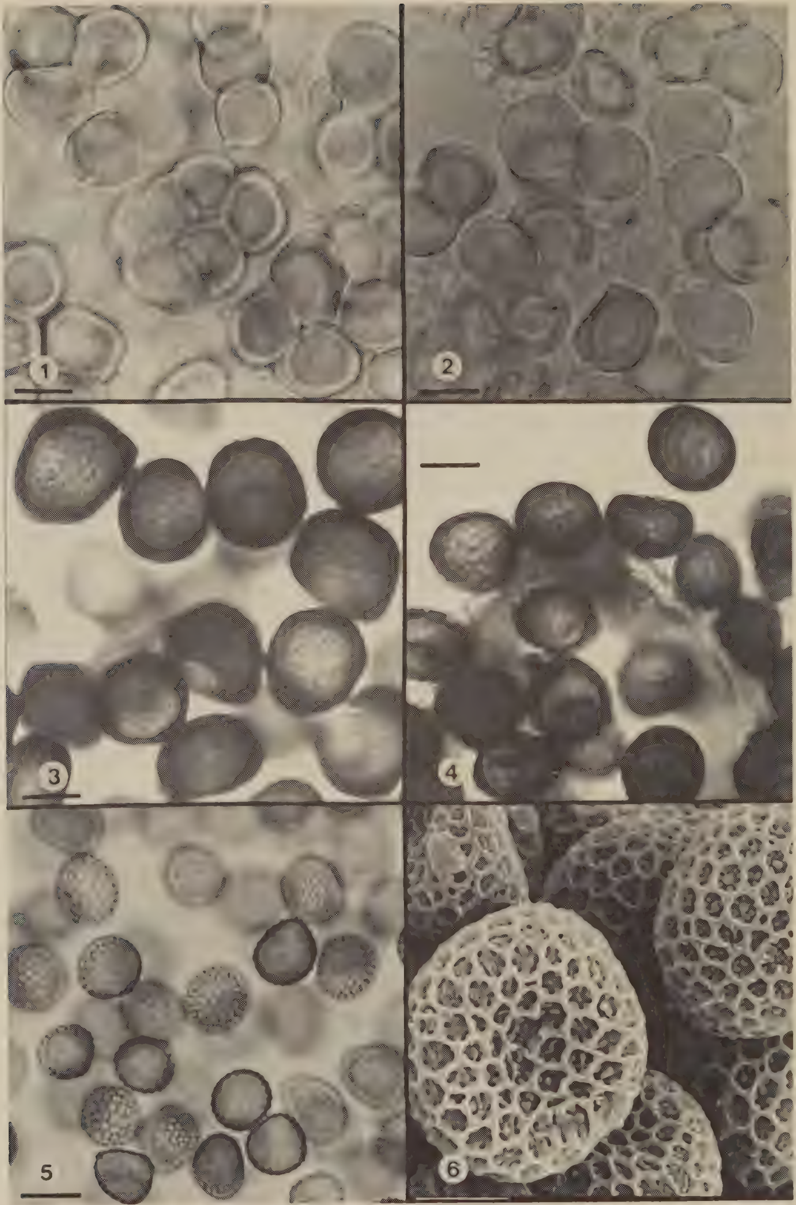
Ustilago dumosa Vánky & Oberwinkler, sp. nov.

Typus in matrice *Rumex dumosus* A. Cunn. ex Meisn., Australia, New South Wales, Moree, 30.X.1961, F.W. Cutting. Holotypus in HUV 6663!, isotypi in BRIP 11845! et in DAR 8533 (sub *Ustilago kuehneana*).

Sori caules ramulosque parum tumefacientes, massa sporarum purpureo-brunnea, semiagglutinata. Sporae globosae, ovoideae, ellipsoideae vel parum irregulares, 9,5–12 x 11–15 µm, pariete flavido-brunneo simul violaceo tincto, sub microscopio normali reticulato, punctato-reticulato vel reticuliformiter punctato cum 6–9 reticulis in diametro sporarum, muris reticuli 0,5–0,8 µm altis, in sectione mediana sicut projectiones obtusiusculae apparentibus, in SEM reticulato, verrucis ad muros et in campis inter muros visibilibus.

Sori (Fig. 8) in slightly swollen stems and branches filled by a purplish-brown, semiagglutinated spore mass. Spores (Figs 5, 6) globose, ovoid, ellipsoidal or slightly irregular, 9.5–12 x 11–15 µm, violet tinted yellowish-brown; wall in LM reticulate, punctate-reticulate or only punctate in a reticulate pattern, 6–9 meshes per spore diameter, muri 0.5–0.8 µm high, in median view appearing as blunt projections, in SEM reticulate with tubercles in the interspaces and on muri.

U. dumosa differs from *U. parlatorei*, i.a., by the different type of reticulate surface ornamentation and by the low muri, in median view appearing as blunt projections; from *U. kuehneana* by the smaller spores and the low, blunt muri.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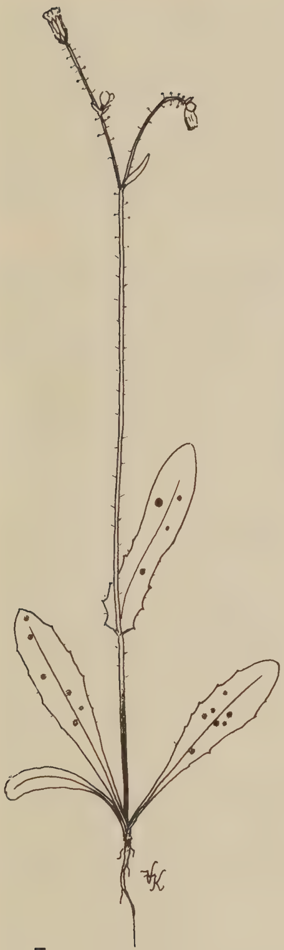

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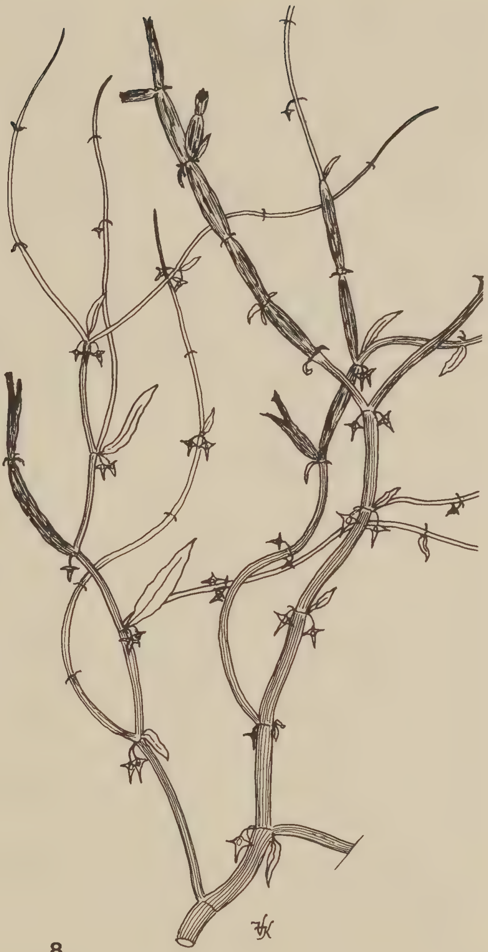

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Fig. 1. Spores of Entyloma crepidis-rubrae (Jaap) Liro. Type.
Fig. 2. Spores of Entyloma zacintha Vánky. Type.
Fig. 3. Spores of Melanotaenium cingens (G. Beck) P. Magnus. Type.
Fig. 4. Spores of Melanotaenium antirrhini Viennot-Bourgin ex Vánky. Type.
Figs 5–6. Spores of Ustilago dumosa Vánky & Oberwinkler in LM and SEM. Type.
Fig. 7. Sori of Entyloma zacintha on Crepis zacintha. Type.
Fig. 8. Sori of Ustilago dumosa on Rumex dumosus. Type.
Bars = 10 µm, except for Fig. 6, where it represents 4 µm.

EXCLUDED SPECIES

E. aristolochiae Saccardo, 1915:32, type on Aristolochia elegans (cult.), Island Malta, San Antonio, 19.XII.1913, G. Borg (417; PAD!).

According to the original description: Sori on withering leaves, decoloring the epidermis, up to 1 mm in diam., surrounded by a black halo. Spores crowded, globose, 12–15 µm in diam., yellowish to dark brown, wall 1–2 µm thick, nearly smooth, with pale plasm, often divided in different ways.

Black sori, dark brown spores with divided protoplasm are not characteristics of an Entyloma. The study of the type specimen showed that the agglomerated fungal cells, yellowish-brown at the periphery, otherwise hyaline, rounded to irregular in shape and size, sometimes elongated and divided, represent immature ascocarps (perithecia) of a pyrenomycete.

Entyloma debonianum Saccardo, 1914:115, type on Oenanthe globulosa L., Island Malta, Ghain Mula, IV.1913, A. Caruano-Gatto (PAD!).

Saccardo described this species as follows: Sori on stems as blackish pustules, 0.5–0.6 µm in diameter. Spores produced in subglobose, intercellular masses 300 µm in diameter. Spores ellipsoidal-globose, 16–17 µm in diameter, with 1–3 hyaline nuclei, wall smooth, about 1 µm thick, yellowish-brown.

The study of the type specimen showed that this is not an Entyloma. The "spores" measure 16–24 µm in diameter. It may be in the Protomycetales, but it is not Protomyces macrosporus Unger, which has much larger ascogenous cells (37–74 µm).

Entyloma erodianum Saccardo, 1915:33, type on Erodium moschatum (L.) Hér., Island Malta, Addolorata, 9.III.1914, A. Caruano-Gatto (388; PAD!). According to the original description, this species is characterised by sori forming light brown, indefinite, amphigenous spots. Spores not crowded but densely and widely situated in the leaf parenchyma, globose or slightly angular-globose, 14–15 µm in diameter, epispore 1.5 µm thick, light yellowish-brown, plasma sometimes divided into 2–4. In withered leaves of Erodium moschatum. Hardly visible. Spores sometimes only 9 µm in diameter.

This description is consistent with the characters of an Entyloma, except the statement that "the plasma is sometimes divided into 2–4". However, the study of the type specimen revealed that the "spores" are, in fact, compact bodies of non-fungus origin. Their form varies from globose to rectangular, measuring 6–20 µm in diameter, composed of numerous concentrical layers. Rarely may be composed of 2–4 pieces. These bodies somewhat resemble starch granules but are iodine negative.

Additional Entyloma species, reported from Geraniaceae, are E. atlantica Massenot, in Guyot, Malençon & Massenot, 1958:187, and E. geranii Kuznetzova & Schwarzman, in Schwarzman, 1960:276.

Entyloma glyceriae Fragoso, 1924:441, type on Glyceria tenuifolia Boiss. & Reuter (= Puccinellia festuciformis (Host) Parl. subsp. tenuifolia (Boiss. & Reuter) W.E. Hughes), Spain, near Barcinona, Castelldefels, VII.1910, F. Sennen (MA 7133!). It was described as having globose to ellipsoidal spores 17–28 µm in diameter. The study of the type revealed that it is Physoderma gerhardtii Schröter (Chytridiales).

Entyloma hydrophilum Saccardo & Paoletti, in Saccardo, 1889:85, type on Sium cicutaefolium Schrank, USSR, Siberia, near Minusinsk, coll. N. Martianoff (LE!, PAD!).

This fungus was described as producing blackish, amphigenous, pustulous sori that never open on the leaves in yellowish, indefinite patches. Spores in the host cells, crowded, subglobose to angular, 24 µm in diameter, epispore thick, brown, nucleus globose, subhyaline, 15 µm in diameter.

Liro (1938:119), without seeing material, suggested that "this species may possibly be identical to Entyloma flavum Ciferri, although the spores are said to measure up to 24 µm".

The study of the type specimen revealed that this fungus is not an Entyloma, either. For the "spore" measurements I obtained 12–24 x 16–26(–30) µm values. The colour of the sori, the morphology of the spores, including the great size, are not typical for Entyloma. It looks like a Protomycetales, but it could not be identified with any of the known members of this order, mentioned by Reddy and Kramer (1975). All three species, Protomyces macrosporus Unger, Burenia cicuta (Lindroth) Reddy & Kramer, and B. inundata (Dangeard) Reddy & Kramer, have much larger ascogenous cells.

Entyloma xanthii was described by Massalongo, in Saccardo 1913:568, on Xanthium strumarium L., from Italy, Verona, Tregnago, "Calavena", summer 1913, coll. C. Massalongo (PAD!). According to the original description "The sori appear on the upper surface of the leaves as abundant, small, circular or angular spots, 2–3 mm in diameter, slightly bullate, no discoloration at the margins, whitish, almost calceolate, on the under side of the leaves the sori have a light olivaceous-yellow colour; spores in the mesophyll, globose to subglobose, in loose groups, fumose, 10–14 µm in diameter; epispore thin, minutely punctate-rough; conidia not seen. A species recognizable rather by the peculiar spots and host plant".

The study of the type specimen of Entyloma xanthii revealed no spores of Entyloma type, only necrotic leaf tissues covered by a white exudate which disappears in boiling water.

Schwarzman (1960:301) described Melanotaenium byzovae, from Galium tenuissimum M.B., USSR, Kazakhstan, Dzhambulskaja obl., Chu-Ilijskii Mts, 10 km from railway station Khantau, 26.V.1958, coll. Z.M. Byzova (AA!). Sori on the stem and leaves, rounded or elongated, bullate, lead-coloured, first "covered by the epidermis", later bursting. Spore mass brownish-violet. Spores globose, rarely ovoid, 9.5–11(–13) x 9.5–13 µm; epispore 1–1.5 µm thick, smooth or obscurely verruculose, pale violet. The study of the type specimen showed that it is a myxomycete.

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ABBREVIATIONS

The abbreviations for herbaria follow Index Herbariorum (Stafleu 1981).
HUV = Herb. Ustilag. Vánky, the author's private herbarium.

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BOOK REVIEWS

by
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THE AGARICALES IN MODERN TAXONOMY, by R. SINGER, 4th. ed., viii + 981 pp., 88 pl., 16 x 24 cm, cloth hardcover, 1986. Koetltz Scientific Books, D-6240 Koenigstein, Fed. Rep. Germany. ISBN 3-87429-254-1. DM 320.-

This is the fourth and, as the author says, "probably last edition" of *Agaricales in modern Taxonomy*, a full treatise of the Agaricales, introduced by an updated critical review of all concepts necessary to the observation and comprehension of that major group of fungi.

The first part, *Critical survey of the characters of the Agaricales as the base of their taxonomy,* is the most enriched part of this edition. It includes many of the recent advances in the taxonomy of the Agaricales, up to 1985. That part should be considered as the necessary guide to any taxonomical study by beginner. In 24 chapters, it deals with most aspects of descriptive taxonomy, from the most technical, like fungus culture or staining, to the most conceptual ones, like taxon definition and phylogeny.

The taxonomical part covers 230 genera, with 1 new genus described in the text, and slightly over 5000 species. The synonymy has been updated, leaving out 87 cases of *genera excludenda et incertae sedis.*

The main changes in the classification are the subdivision of the Agaricales into three suborders, the Agaricinae (11 families including Agaricaceae and Polyporaceae), the Boletineae and the Russulineae (with Bondarzewiaceae and Russulaceae), the creation of new tribes or subtribes in the Tricholomataceae, the major family of the Agaricales, (e.g. the tribe Termitomyceteae for *Termitomyces* and *Podabrella*, the subtribes Laccariinae (*Laccaria*), Clitocybinae (*Clitocybe*, a.o.), Omphalinae (*Armillariella*, a.o.) and Tricholomatinae (*Tricholoma*) under the tribe Tricholomateae in the Tricholomataceae), the transfer of the genera *Omphalotus* and *Lampteromyces* from the Tricholomataceae to the Paxillaceae.

This really monumental monograph is the work of a mycologist with a world-wide knowledge of the fungi, an extended and up-to-date acquaintance with literature and a deep minded criticism based on acute observation. The book shall remain a milestone in the systematics of higher fungi, to which any current or future mycologist will refer.

But progress towards modern taxonomy shall continue. One shall have to remember Singer's guarding words against the belief that multiplication, reorganization or upgrading of taxa necessarily make taxonomy modern. "Approximation towards a natural classification", he says, "requires patient comparative studies on the whole spectrum of characters available now or newly made available, on the largest possible number of taxa of the world mycoflora. The resulting conclusions, sometimes fortified by numerical methods, will produce a natural classification, and that approach is, I believe, the main characterisitc of modern taxonomy."

THE BIOLOGY OF MARINE FUNGI, edited by S.T. MOSS, 382 pp., ill., 17 x 25 cm, cloth hardcover, 1986. Cambridge University Press, Shaftesbury Road, Cambridge CB2 2RU, UK. ISBN 0-521-30899-2. £27.50.

If there are a large number of fungi restricted to marine substrates or marine environment, which justifies studies of the marine mycoflora, *marine mycology* is not a field apart from mycology. This is once more demonstrated through the reading of the set of 30 papers presented by 42 contributors at the Fourth International Marine Mycology Symposium held at Portsmouth Polytechnic, U.K., in August 1985.

In regard to taxonomy, two major lines are the Labyrinthulales and the Mastigomycota with 3 papers on one side, and the Ascomycota with 8 papers (5, 6, 18-23) on the other. Modern taxonomical methods are used, such as G+C% values and enzymatic profiles. A more heterogeneous cluster of paper deals with physiology of the marine fungi (including yeasts and Deuteromycetes also) in relation to their environment and its salinity, their biomass production, their competitive substrate colonization, referring to salt, glycerol and polyol concentration, fatty acid, ergosterol, enzyme profiles and secondary metabolite production. Four papers (13-15 and 17) deal with pathogenic fungi causing mycoses of marine organisms, while one considers the mutualistic symbiosis between *Mycosphaerella ascophylli* and the brown alga *Pelvetia caniculata*. Geographical distribution of the marine fungi is analysed in four papers, with interesting results by cluster analysis. As mycology has always had some practical aspects of biotechnological interest, four papers approach such features as hydrocarbon degradation by fungi, mycelial adhesion to surfaces, patterns of timber decay and wood preservation.

The title of the book might suggest a comprehensive treatment of the biology of the marine fungi in their specificity but is too promising. From the contributions it is not clear what makes marine fungi different from others. However, they are of real interest at the levels of general documentation and specific research progress.

FILAMENTOUS MICROORGANISMS: BIOMEDICAL ASPECTs, edited by Tadashi ARAI, xvi + 460 p., ill., 16 x 23 cm, cloth hardcover, 1985. Japan Scientific Societies Press, Tokyo. Distributed: Business Center for Academic Societies Japan, Koshin Bldg., 6-16-3 Hongo, Bunkyo-ku, Tokyo 113. ISBN 4-7622-8432-7. US$50.00.

This book contains the 34 papers presented at the International Symposium on Chemiobiodynamics devoted to taxonomy, toxicogenicity and infections by filamentous organisms, held at Chiba University on 5-6 September 1983. In his overview of the subject, C.V. Subramanian emphasizes the benefits medical mycology takes from advances in descriptive mycology. In regard to the peculiar and difficult problems in the identification of medically important fungi, the contributions of Hughes, Yokoyama, Malloch, Onions, McGinnis, Udagawa, Samson and Cole offer a critical synthesis of the current descriptive research, taxonomy and nomenclature of the major groups of fungi in relation to health. This comprises the ontogenesis of chlamydospores, morphogenesis of *Coccidioides immitis*, and reviews of the Coelomycetes, the Trichocomaceae and their anamorphs *Penicillium*, *Aspergillus* and others, the pathogenic dematiaceous hyphomycetes, the thermophilic and thermotolerant fungi, as well as the food moulds.

The mechanisms of fungal infections, their biochemical agents, such as fungal toxins, the defensive reactions of the organism, and the effects of food mycotoxins on the organism are considered in special sections. Also basic and clinical aspects of antifungal chemotherapy is the subject of the last section of the book.

DEVELOPMENTAL BIOLOGY OF HIGHER FUNGI, by MOORE, D., L.A. CASSELTON, D.A. WOOD and J.C. FRANKLAND, British Mycological Society Symposium vol. 10, 615 pp., ill., 15 x 23 cm, cloth hardcover, 1985. Cambridge

University Press, The Edinburgh Building, Shaftesbury Road, Cambridge CB2 2RU, U.K. ISBN 0-521-30161-0. £70.- US$99.50

These transactions of the 1984 annual British Mycological Society Symposium held at Manchester are actually the joint publication of two different symposia, the first on "Resource Relationship of Agarics" (the first six chapters of the book) and the other on "Developmental Biology of the Agarics" (the other twenty-one chapters).

The first part of the book reviews concepts and cases of the fungus-host or fungus-substrate relationship in the Agaricales, characterized as saprotrophy, necrotrophy, mycorhizal or pathogenic biotrophy. Particular attention is given to the dynamics of vegetative development and fruiting, in cases like the agaric community in tropical forest, *Crinipellis perniciosa* on cocoa trees, and *Armillaria* in temperate forests.

The second part of the book is a progressive series of papers going from the fundamentals in cellular biology to the practical management of mushroom production. Each of the 24 papers of that part is of real interest, such as the role of the dolipore, dikaryon formation, the mechanism of anastomosis. Then the morphogenesis of vegetative organs such as the stipe leads to that of fruitbodies, with an important paper by Roy Watling on the developmental characters in the Agaricales. After the biochemistry of morphogenesis and particularly that of fructification, the genetics of development is reviewed. The series ends with some new ideas for mushroom breeding strategies and mushroom cultivation techniques. Most of the papers presented are reviews of results published elsewhere. But all together they provide both fundamentally and practically oriented mycologists with a detailed and well-documented account of the today's knowledge in the field.

PLANT PATHOGENIC FUNGI, by von ARX, J.A., Beihefte zur Nova Hedwigia, 87, 288 pp., 105 fig., 17 x 24 cm, paperback, 1987. J. Cramer in der Gebrüder Borntraeger Verlag, D-1000 Berlin, Germany. ISBN 3-443-51009-4.

This book, the last one that late Dr von Arx published, is aimed to introduce mycologists to tplant pathogens and plant pathologists to mycological classification. It is framed according to the systematic scheme of the fungi that von Arx published in *Pilzkunde* (1976) and *Fungi sporulating in pure culture* (1981) but with some changes, a few of these from *Mykologie* by Müller and Loeffler (1983). In that scheme of 6 phyla (=divisions), the major subdivisions up to the orders are described. A selection of briefly described genera, based on their importance or relation to plant disease or post-harvest decay, are commented upon with added lists of some relevant species. The book is well illustrated and contains numerous keys but references to the literature are limited to genera and to higher taxa only and are not numerous.

The major changes in the taxonomical scheme are the recognition of Endogonaceae as Endogonales, the recognition of the Endomycetes as a class of the Ascomycota, with the exclusion of the basidial orders, the change of Pseudosphaeriales into Dothideales, the recognition of the Meliolales, the surprising agregation of the Helotiales (inoperculates Discomycetes) into the Phacidiales, the recognition of the classes Ustomycetes and Urediniomycetes in the Basidiomycota, but with the Tilletiales in the class Basidiomycetes (=Hymenomycetes) near the Exobasidiales, and the division of the Agaricales into 4 orders, Polyporales, Agaricales, Russulales and Boletales. That scheme differs largely from the now classic one in *The Fungi* IVA-B by Ainsworth, Sparrow and Sussman (1973).

The most interesting feature of the book is the presentation of the Deuteromycetes (although the old divisions Sphaeropsidales, Melanconiales and Moniliales are still given) into 4 groups of anamorphs relatated to taxonomical ascomycetous orders, as anamorphs of Dothideales, of Sphaeriales, of Phacidiales and of others. This presentation may remind one that the biological unit is the holomorph and that the fungal pathogen should bear the name of it. If that, as I believe, was the opinion of the author, I cannot explain why he was reluctant to recognize *Botryotinia* as distinct from

Sclerotinia on the basis of such diagnostic holomorphic characters as sclerotia and conidiomata provide.

Von Arx has provided us with an interesting way of teaching plant pathogenic fungi.

ENTOLOMA (AGARICALES) IN EUROPE. Synopsis and keys to all species and a monograph of the subgenera Trichopilus, Inocephalus, Alboleptonia, Leptonia, Paraleptonia and Omphaliopsis. by M. E. NOORDELOOS, Beihefte zur Nova Hedwigia vol. 91, vi + 419 p., 128 fig., 17 x 21 cm, paperback, 1987. J. Cramer, Gebrüder Borntraeger, D 1000 Berlin, D 7000 Stuttgart. ISBN 3-443-51013-2.

This is an additional piece of work that the author adds to his already published partial monographs of the genus *Entoloma*, especially of subgenera *Pouzarella*, *Nolanea*, *Allocybe* and *Entoloma* in *Persoonia*, 1979, 1980 and 1981. The present book contains the monograph of five other subgenera, *Trichopilus* (6 species), *Inocephalus* (8 spp.), *Alboleptonia* (4 spp.), *Paraleptonia* (4 spp.), *Omphaliopsis* (3 spp.) and *Leptonia*, with 3 sections *Leptonia* (16 spp.), *Griseorubida* (7 spp.) and *Cyanula* (49 spp.). All species have been collected from Europe, in many different habitats. They are fully described, with much care and precision and illustrated by an half or full page of line drawings.

In another part of the book, the author has compiled and disposed in taxonomic order all the 226 species of the genus *Entoloma* in Europe, including those redescribed or described as new in this monograph. Species names that are not monographed in this book are entered with indications of typification, synonymy, misapplications, references to literature and illustrations and notes. A very elaborate dichotomous key, covering 17 pages but subdivided into 11 limited keys, allows the identification of all 226 species. The book is completed by a documented list of 177 insufficiently known or excluded taxa, accompanied with comments on type analysis, short description, taxonomic remarks and their taxonomical position in *Entoloma* when dubious or in other taxa when excluded.

This work results from 10 years of field and desk research. It is an important contribution to that very large genus, known by its many species from other parts of the world.

INTRODUCTION TO FOOD-BORNE FUNGI, edited by SAMSON, R.A., E.S. HOEKSTRA and C.A.N. VAN OORSCHOT, 2d edition, 248 pp.,ill., 21 x 30 cm, paperback, 1984. Centraalbureau voor Schimmelcultures, P.O. Box 273, 3740 AG Baarn, The Netherlands. ISBN 90-70351-03.

More than the title might suggest, this book is a comprehensive guide to the whole problem of fungal contamination of food. The major part (205 p.) is of course devoted to the identification of almost one hundred food-borne fungi amongst the Zygomycetes, Ascomycetes, Deuteromycetes and the yeasts. Two facing pages are given to every described species, one for the description and outline drawings, the other for excellent black and white photographs of cultures and microscopic features. There follow four other chapters (31p.) by different authors on isolation and quantification of fungi in food, mycotoxin production, mycotoxin sampling, detection and identification, heat resistance of fungal spores and yeast cells and food preservatives. A last chapter, for a good balance of the contents, reminds the reader that moulds are not all noxious, but some are harmless and used in production of fermented foods. Each chapter is completed with a long literature list, the book itself by a glossary and a species index.

This guide has proven very useful to many microbiologists and the first edition was rapidly out of print. This second slightly revised edition is most welcome.

TROPICAL MUSHROOMS, Biological Nature and Cultivation Methods, by CHANG, S.T. and T.H. QUIMIO, xxi + 493 pp., 16 x 24 cm, ill., cloth hardcover, 1982. The Chinese University Press, Chinese University of Hong Kong, Shatin, N.T. Hong Kong, China. ISBN 962-201-264-7.

This is a concise, in-depth treatment of the knowledge on mushroom sicence for tropical countries. It is divided in five parts. Part 1 is for general aspects of mushroom cultivation, such as genetics and breeding, spawn production, substrates for mushroom production, preservation, chemical analysis. Part 2 deals with morphology, physiology, enzymatic activities, ecology of *Volvariella volvacea*, its cultivation in Southeast Asia, Philippines and India and its nutritive value. Part 3 details the biology, physiology, environment and cultivation techniques of *Pleurotus* species, and their nutritive value, with a special case of using cotton waste as a substrate. In Part 4 *Auricularia politricha* and other species, often called the Chinese mushrooms, show a broad taxonomic and population diversity. Their growth and fruiting physiology has been investigated. Their cultivation on composted sawdust in the Philippines and on logs in China is commented upon. In Part 5 the cultivation of *Termitomyces* species by termites in natural habitats is described, while no cultivation by man has been successful. The book is an excellent state of the art, in the tropical countries, and is invaluable for anyone interested in mushroom production. But from its reading it becomes also clear that mushroom taxonomy, physiology, genetics and culture, as well mushroom quality as food, urgently need extensive scientific investigations, and that should concern mycologists in the field.

HANDBOOK OF INDIGENOUS FERMENTED FOODS, edited by STEINKRAUS, K.H., Microbiology Series vol. 9, ix + 671 pp., fig., ill., 18 x 26 cm, cloth hardcover, 1983. Marcel Dekker, Inc. 270 Madison Ave, New York, NY 10018, U.S.A. 0-8247-1848-8.

This book is based upon papers submitted to the Symposium on Indigenous Fermented Foods (SIFF) held in Bangkok, Thailand, in November 1977. Let us recall that, while *Saccharomyces cerevisiae* was recognized and cultured as beer years in Mesopotamia by 6000 B.C., many other fungi are actually or potentially involved in food fermentation and that, today, at the least one-tenth of the world's population consume less food than their bodies need. We know that food fermentation, a practical end of mycology, cannot be forgotten. The book deals mainly with tropical food fermentations, including tropical mushroom cultivation, but is of general application. *Absidia, Actinomucor, Chlamydomucor, Mucor, Rhizopus, Aspergillus, Penicillium, Fusarium, Geotrichum, Monascus, Chrysonilia,* and *Neurospora* are the main filamentous fungus genera involved. *Brettanomyces, Candida, Debaryomyces, Endomycopsis, Hansenula, Kluyveromyces, Rhodotorula, Saccharomyces, Schizosaccharomyces* and *Zygosaccharomyces* are the yeast genera concerned. The book is divided in 6 sections: protein-rich foods, acid fermentations, alcoholic foods, amino acid/peptide sauces, mushroom production, developments and problems in fermented foods. The book is profusely documented with references.

ZUR OKOLOGIE DER PORLINGE, II, by Ingo NUSS, Bibliotheca Mycologica vol. 105, 300 pp.,182 pl., 38 tab. + 57 diagr., 14 x 22 cm, paperback, 1986. J. Cramer in der Gebrüder Borntraeger Verlag, D-1000 Berlin, Germany. ISBN 3-443-59006-3.

This heavy document consists of 187 pages of dense text, 100 pages for 187 outstanding drawings and black and white photographs of carpophores and 140 pages of diagrams and tables, with the addition of 16 diagrams on 3 to 4 folded pages, and an index. More than 100 specimens of 31 perennial species of polypores (*Fomitiporia, Fuscoporia, Inocutis, Ochroporus, Phellinidium, Porodaedalea, Bondarzewia, Fomes, Ganoderma, Gloeophyllum, Skeletocutis* and *Trametes*) have been surveyed weekly over two years and investigated for the growth of the hymenium (tubes), spore liberation, odor and guttation, in relation to external climatic factors.

The author distinguishes three groups of hymenial development. In a first group (*Trametes gibbosa*) the hymenium does not increase after the first year but continue to sporulate. In the second group, the hymenium increases in size during successive years, forming successive prolongation of the one-year tubes, so that the tubes remain open, are continuous from year to year and keep sporulating (*Fomitiporia hartigii, Ganoderma adspersum*). In this group annual hymelial layers are less conspicuous than in the third group. The third group has new annual hymenial growth but after closure by tramal hyphae of the pre-existing tubes (*Fimitiporia robusta, Ganoderma applanatum*). Those features should contribute to the taxonomy and the identification of polypores. *Fuscoporia (Phellinus) ferruginosa* is suggested to be divided in two species, for it shows the two type of successive hymenial growth. Those features are remarkably illustrated.

Sporulation periods depend on both the type of perennial polypores, and the species itself. It can be either continuous all through the year or discontinuous, with one or two spore liberation periods. The author gives a full detailed account on the spore release periodicity.

The book contains much more information that surely all those interested in the biology and ecology of the polypores will want to read.

Notice: an index and a 4 pages corrigendum of *Zur Ökologie der Porlinge I* is added as a loose leaflet.

AD POLYPORACEAS IV, by CORNER, E.J.H., Beihefte zur Nova Hedwigia vol. 86, 265 pp. + 35 fig. and 11 pl.,17 x 25 cm, cloth hardcover, 1987. J. Cramer in der Gebrüder Borntraeger Verlag, D-1000 Berlin, Germany. ISBN 3-443-51008-6.

The subtitle of the book indicates its contents: "the genera *Daedalea, Flabellophora, Flavodon, Gloeophyllum, Heteroporus, Irpex, Lenzites, Microporellus, Nigrofomes, Nigroporus, Oxyporus, Paratrichaptum, Rigidoporus, Scenidium, Trichaptum, Vanderbylia* and *Steccherinum*." The study of species in those genera is based on Dr. Corner's collections from Southeast Asia, the Solomon Islands and Brazil. Corner follows the Ryvarden's taxonomy of temperate species. Therefore, it is not surprising that he describes 56 new species and one new genus, *Paratrichaptum*, from that little explored tropical mycoflora. The species are illustrated by 8 color plates and three photographs. But this fourth volume like the previous three is not a description of tropical species only. Each generic concept is analysed and discussed in regard to others for its developmental morphology. That should meet the interest of many mycologists.

BEITRAGE ZUR KENNTNIS DER PILZE MITTELEUROPAS, II, 240 pp., ill., 6 coul. pl., 17 x 24 cm, paperback, 1986. Einhorn Verlag, Eduard Dietenberger GmbH, Schwäbisch Gmund, Germany.

This is the second issue of the Arbeitsgemeinschaft Mycologie Ostwürttemberg (AMO) der Deutschen Gesellschaft für Mycologie, in honor of three German mycologists, W. Stein, J. Krok and the late H. Seemann. Twelve contributions concern more than 56 species of Basidiomycetes in the genera *Amanita, Conocybe, Entoloma, Flammulaster, Hebeloma, Hypholoma, Inocybe, Lentinellus, Lepista, Macrolepiota, Mycena, Naucoria, Omphalina, Paneolus, Phaeotella, Pholiotina, Picoa, Psathyrella, Psilocybe, Pterula, Riparites, Russula, Stephanospora, Tyromyces* and *Volvariella* and include special analyses of the genera *Callistosporium, Tricholomopsis* and *Psilocybe*, an interesting detailed key to the *Agaricus* species by M. Meusers (p.27-56) and an illustration of the microscopical features useful in the identification of *Russula*. Four papers concern the Ascomycetes, two on the genera *Melastiza* and

Heyderia , the two others on the discomycetes on *Filipendula ulmaria* and on 16 interesting Pyrenomycetes of the Bavarian Alps.

FUNGAL DIFFERENCIATION, A Comtemporary Synthesis, edited by SMITH, J.E., Mycology Series vol. 4, xii + 624 pp., ill., 16 x 23 cm, cloth hardcover, 1983. Marcel Dekker, Inc. 270 Madison Ave, New York, NY 10016, U.S.A.ISBN 0-8247-1734-1.

This *Mycology Series* is the place for publication of works dealing with all aspects of mycology, particularly in its progress and in its relation to man. for instance biodeterioration, toxicity, pathogenicity or environmental adaptation. How morphogenesis and variations of the form can be achieved at a biochemical and cellular level in a large range of fungi is the subject of this book. That the matter is treated by 33 contributors in 19 chapters indicates also the diversity of aspects. After an attempt to define differenciation and the recognition of the cell polarity as a major factor of it in the introductory chapter, some chapters study the biochemical mechanisms of the morphogenesis in the slime molds and of cell polysaccharide synthesis (chitin synthesis) in *Blastocladiella*.. Two chapters deal with yeasts, one on cell division, the other on ascospore formation. The next one details the so far known inhibition mechanisms of macromolecule synthesis and other factors that lead to fungal dimorphism yeast/hypha. Then a series of chapters reviews morphogenesis at the cell chemistry level in connection to genetic commands and external factors, of different developmental phases of the filamentous fungi: spore dormancy release, spore activation and spore germination, hyphal tip growth, colony patterns, sclerotial formation, conidiogenesis, sexual response from pheromones, and fruitbody development. A final chapter deals with genetic recombinations after fungal protoplast fusion in fungi and possible manipulations. The reading of the text requires some special acquaintance with cell molecular biology and chemistry, but the content being reviewed from a very large literature is an extremely rich source of information for the initiated.

MICROBIAL DEGRADATION OF ORGANIC COMPOUNDS, edited by GIBSON, D.T., Microbiology series vol. 13, x + 535 pp., ill., 16 x 23 cm, cloth hardcover, 1984. Marcel Dekker, Inc. 270 Madison Ave, New York, NY 10016, U.S.A. ISBN 0-8247-7102-8. $ 107.50.-

Biodegradation of organic compounds is the fact for fungi as for other partners of the microbial world. Pasteur demonstrated it for the first time. This book's broad scope reviews some known processes of biochemical degradation with the help of 26 specialists. Biodegradation of C1 coumpounds, of alicyclic compounds, of aromatic hydrocarbons, of furans and lignin, and of pesticides such as halophenes, halogenated aromatic compounds, polychlorinated biphenyls or phtalates, is reviewed on the basis of an extended literature. In processes of degradation of monocarbon and alicyclic compounds (chapters 3 and 4), fungi and particularly yeasts are known to be involved. Lignin degradation is the characteristic of basidiomycetes and the chapter by T.K. Kirk is most interesting. In most processes, bacteria are the agents. But undoubtedly, fungi have still unexplored properties that this book may stimulate approaching. Also, fungal secondary metabolites produced by fungi, like the furans from *Aspergillus* and *Penicillium* species, are in turn biodegraded by other organisms, and that is another aspect of interest of this book. The increasing importance of fungal biodegradation today justifies recommending the book to fungus physiologists and biochemists, as well as to plant pathologists.

BRITISH FUNGUS FLORA, 5. Strophariaceae & Coprinaceae p.p., by WATLING, R. and N.M. GREGORY, 119 p., ill., 15 x 24 cm, paperback, 1987. Royal Botanic Garden, Inverleith Row, Edinburgh EH3 5LR, UK. ISBN 0-9504270-7-1. £8.-

This part of the fungi of the British Islands contains the characters of the family of Strophariaceae with four genera, *Hypholoma* (15 species), *Melanotus* (6 species), *Psilocybe* (25 species) and *Stropharia* (11 species). Two genera, *Panaeolus* (14 species) and *Lacrymaria* (3 species) are complemental to the already revised family Coprinaceae (Part 2). Keys to genera and species are provided.Amongst the indexes, a list of 23 misidentifications and of 54 rejected names and a list of the species disposed according their ecological niches are noteworthy. The genus *Nematoloma* is rejected for *Hypholoma*. *Psilocybe* is not as large as *Psilocybe* sensu Kühner (including *Stropharia* and *Hypholoma*) but includes species of *Deconica* and some species only of *Stropharia*. *Psilocybe*, as opposed to *Stropharia*, does not have chrysocystidia. *Panaeolina foenisecii* is returned to *Panaeolus*. *Pholiota (Kuehneromyces, Galerina) mutabilis* is not considered. This part is of special interest in the identification of halucinogenic fungi.

FLORA CRIPTOGAMICA DE TIERRA DEL FUEGO, Orden Helotiales, Orden Cyttariales, by GUARRERA, S.A., I. GAMUNDI DE AMOS and D. RABINOVICH DE HALPERIN, Flora Criptogamica de Tierra del Fuego vol. X(4), 266 p., 31 pl., 16 x 24 cm, paperback, 1986 (published July 1987). Consejo Nacional de Investigaciones Cientificas y Tecnicas Rivadavia 1917, Buenos Aires, Republica Argentina.

This part of the fungus flora of the Tierra des Fuego includes the family Cyttariaceae (Order Cyttariales), with the genus *Cyttaria* and 4 species,and in the Helotiales the family Geoglossaceae (8 species) with genera *Sarcoleotia*, *Trichoglossum, Thuemenidium, Scleromitrula, Pseudomitrula* and *Heyderia*, and the family Dermateaceae (30 species), with *Calycellina, Haglundia, Tapesia, Mollisiopsis, Mollisia, Niptera, Dermateopsis, Ocellaria, Propolomyces, Pseudopeziza, Hysteropezizella, Merostictis, Pirottaea* and *Trochila*. *Calycellina hygrophila, Tapesia fusca* var. *microspora, Mollisia cinerella* var. *citrinoreflecta, M. glutinosa, M. crocata* and *Merostictis aciculispora* are new described taxa. *Tapesia brachycarpa* is a new combination. All species are very carefully drawn on 31 full pages.

PRELIMINARY LIST OF VIETNAMESE APHYLLOPHORALES AND POLYPORACEAE s. str., by PARMASTO, E., 88 pp., 14 x 20 cm, paperback, 1986. Academy of Sciences of the Estonian SSR, Institute of Zoology and Botany, 21 Vanemuise St., 202400 Tartu, U.S.S.R.

This is a compilation of all the 227 species of Aphyllophorales and Polyporaceae known in Vietnam, together with 83 doubtful ones. The list is taxonomical. The names are commented upon with reference to published data and to locality and habitat of collection. No identity checking has been made on herbarium material. The aim of the paper is to make ta first step towards further exploration of the Vietnam mycoflora. (In both Russian and English)

PROBLEMS OF SPECIES AND GENUS IN FUNGI, edited by PARMASTO, E., 194 pp., 14 x 20 cm, paperback, 1986. Academy of the Estonian SSR, Institute of Zoology and Botany, 21 Vanemuise St., 202400 Tartu, U.S.S.R.

What is the species, is a debatable question. The author dared to raise it to 19 mycologists specialized in the different groups of fungi. The answers make the chapters (in Russian, but with English summaries) of this interesting document. A distinction must be made between the *species concept* (morphological, biological), the *species definition* (based on the characters corresponding to the species concept) and the *species standard* (or set of criteria delimiting the species). For a number of the 19 authors, the only species problem is how to elaborate the species standard and build keys from it. If for some the species concept is strictly a morphological one, for others it is the concept of a biological species that prevails. Yet there are some divergences. How to qualify the uniparental species (the "asexual" species in Deuteromycetes)?

Heterokaryosis and parasexuality have not been investigated far enough to qualify uniparental species as biological species and some prefer to call them *pseudospecies*. Also, what are the intersterile groups of morphologically indistinguishable individuals in tetrapolar or multipolar Hymenomycestes? Would they or should they be called *ultraspeciies?* One knows sibling species and microspecies. But they are not accepted by everybody and often grouped in *collective species, species aggregates, supraspecies* or *macrospecies*. But these categories are supraspecific and should not be confused with species.

The debate is open. The matter is not discussed as a pure abstraction or a pure terminological problem, but practically through a full range of examples from all the groups of fungi.

BIODETERIORATION 6, edited by Sheila BARRY, D.R. HOUGHTON, G.C. LLEWELLYN and C.E. O'REAR, xv + 691 p., ill., 19 x 26 cm, cloth hardcover, 1986. The Biodeterioration Society and CAB International Mycological Institute, Farnham House, Farnham Royal, Slough SL2 3BN, U.K. ISBN 0-85198-555-6.

This is the proceedings of the Sixth International Biodeterioration Symposium held in Washington in 1984. The topics of the Symposium cover a very wide range of field due to the diversity of biological agents and of biodegradable substrates. The fungi have therein an importance place. The 129 papers are grouped into 14 sessions. The session topics are general aspects of biodeterioration and biodegradation, corrosion of metals, biodeterioration of museum objects, library and archive materials, biodegradation of effluents, fuels, polymers, lignocellulose, paints and plastics, marine biodeterioration, rapid detection methods of biodeterioration, deterioration by insects, control of biodeterioration, mycotoxin production. About one fifth of the papers are related to fungi. They deal with deterioration of different substrates, like wood, textiles, paints, natural and artificial stones and metal plates or pipes, with the control of the fungi by natural substances or by chemicals, the resistance testing of materials to fungi, the production of mycotoxins and their degradation, the biodegradation of those toxins. 108 species of fungi are cited in the test. An organism index and a subject index complete the very neatly edited book.

MUCL LIST OF CULTURES 1989. FUNGI-YEASTS. by HENNEBERT G.L. and Coll., xxii + 360 p., 21 x 29 cm, paperback, 1989. Mycothèque de l'Université Catholique de Louvain, B-1348 Louvain-la-Neuve, Science Policy Office of Belgium, 8, Rue de la Science, 1040 Bruxelles. FB600.-

This is the first edition of a catalogue of the fungi and yeasts kept in pure culture at MUCL collection. It includes almost 5000 strains, most of Zygomycetes, Ascomycetes, Basidiomycetes and Deuteromycetes. The data includes a nomenclator, the strain origin, status, history, optimal growth conditions, state of preservation and some properties like enzyme production, industrial applications, assays, etc. The living collection consists of 15000 strains derivated from half the 30000 specimens kept in MUCL mycological herbarium.

MUCL, together with IHEM collection of fungi related to man (6000 strains, Brussels) and LMG collection of bacteria (8000 strains, Ghent), make up the Belgian Coordinated Culture Collections (BCCM), a consortium coordinated by the Sciences Policy Office of Belgium. The three catalogues are available on request, free of charge to those answering a survey on the use of microbial strains. All data in the collections are in databases according the general dataformat agreed upon by the Microbial Information Network Europe (MINE).

MYCOTAXON

Vol. XXXVI, No. 2, p. 493 January-March 1990

NOTICE

FOURTH INTERNATIONAL MYCOLOGICAL CONGRESS: SECOND CIRCULAR

The Second Circular for IMC_4, to be held in Regensburg, Germany, from August 28th through September 3rd, 1990, has been mailed to those expressing interest. Sixty symposia are arranged in six parallel sessions in seven Sections, the organizers given here in parentheses: Systematics and Evolution (F. Oberwinkler), Morphology and Ultrastructure (R. Agerer), Ecology (J. Webster), Genetics and Physiology (U. Stahl), Biotechnology and Applied Mycology (P. Präve), Pathology (H. J. Schwinn), and Special Topics (B. Hock). There will also be an Honorary Lecture by K. Esser entitled *Molecular aspects in aging — facts and perspectives*, a series of General Lectures, Poster Sessions, Workshops, Exhibitions, Films, and pre- and post-Congress Excursions.

Those who have not received this circular may obtain one by writing:

IMC 4 / Prof. Dr. A. Bresinsky
Botanisches Institut der Universität
D-8400 Regensburg
Federal Republic of Germany

MYCOTAXON

Vol. XXXVI, No. 2, p. 494 January-March 1990

NOTICE

XI CONGRESS OF THE INTERNATIONAL SOCIETY FOR HUMAN AND ANIMAL MYCOLOGY

The Canadian Society for Medical Mycology has issued a First Announcement for the Congress to be held in Montréal, Québec, Canada, from June 24th-28th, 1991. The Congress is sponsored by them in collaboration with the International Society for Human and Animal Mycology (ISHAM) and the Université de Montréal.

To obtain a copy of the Announcement, which includes a card to be completed in order to receive the Second Announcement, write:

XI Congress of the International Society for Human and
Animal Mycology
c/o JPdL Multi Management Inc.
1410 Stanley, Suite 609
Montréal, Québec H3A 1P8
Canada

MYCOTAXON

Vol. XXXVI, No. 2, p. 495 January-March 1990

NOTICE

SUBSCRIPTION PRICE INCREASE

We regret having to inform subscribers that a price increase for subscriptions to MYCOTAXON is necessary in order to meet the increasing costs of production.

This is the journal's first price increase since volume **14**. Few other journals have been able to maintain their subscription prices for such a long period without increases.

The new rates, effective with volume **37** and with *all* orders received after 1 February 1990, is:

Regular (Multi-user) Rate:	$55.00 per volume
Personal (Individual) Rate	$25.00 per volume

Subscribers qualify for the Personal Rate by agreeing not to give, sell, or deposit their copies in any library other than their personal one within three years after receipt.

All back volumes are still available. As in the past, orders for *complete runs* (vol. **1**—last complete volume) and for runs that *complete* a subscriber's set are available at a 20% discount, reflecting postal savings involved in multi-volume shipments. Prices for the Cumulative Index to Volumes I-XX, for copies of the Thiers *Festschrift* number, and for Chupp's book on *Cercospora* remain unchanged.

MYCOTAXON

Vol. XXXVI, No. 2, p.496 January-March 1990

NOTICE

IMPORTANT CHANGE IN EDITORIAL POLICY REQUIRING SUBMISSION OF REVIEWERS' COMMENTS

Effective immediately, authors are required to enclose the full pre-submission reviews (or copies thereof) of their paper at the time they send in their camera-ready copy. If the reviews were based on a manuscript substantially modified after review, a copy of the manuscript as submitted for review must also accompany the camera-ready copy.

Many authors already use this procedure. The previous requirement, to provide merely the names and addresses of reviewers, is thus no longer sufficient for acceptance of manuscript for publication.

AUTHOR INDEX, VOLUME THIRTY-SIX

Almeida, Rogério T., Scientific names in the Endogonales, Zygomycotina 147-159

Anon., NOTICE: XI Congress, International Society for Human and Animal Mycology 494

Anon., NOTICE: Fourth International Mycological Congress: Second Circular 493

Anon., NOTICE: Important change in editorial policy requiring submission of reviewers' comments 496

Anon., NOTICE: Subscription price increase 495

Antonín, Vladimír, Type studies in marasmioid and collybioid fungi (Tricholomataceae) II. *Agaricus graminum* 19-27

Arendholz, Wolf-Rüdiger, The genus *Pezizella* I.: nomenclature and history 283-303

Bakalova, Ganka G., see Vanev and Bakalova

Baroni, Timothy J., Entolomataceae in eastern North America I: new species of *Claudopus* and *Rhodocybe* from the southern Appalachian Mountains 313-323

Baudišová, Dana, see Klán & al.

Brusse, Franklin A., Three new species in the lichen genus *Parmelia* (Parmeliaceae, Ascomycotina) from southern Africa, with further notes 305-311

Cabello, Marta N., Deuteromycotina from Antarctica. New species of hyphomycetes from Danco Coast, Antarctic Peninsula 91-94

Callan, Brenda E., and Jack D. Rogers, Teleomorph-anamorph connections and correlations in some *Xylaria* species 343-369

Calvelo, Susana, and Laura Lorenzo, A new species and first record of *Gymnopaxillus* (Hymenogastrales) from Argentina 163-168

Carris, L. M., *Vaccinium* fungi: *Helicoma vaccinii* sp. nov. 29-34

Checa, Julia, and Angel T. Martínez, Description of the anamorph of *Valseutypella multicollis* in culture 43-45

De, A. B., Nomenclature and synonymy of *Stereum spadiceum* var. *plicatum* 455-456

Durán, R., and P. M. Gray, Nuclear DNA, an adjunct to morphology in fungal taxonomy 205-219

Fleig, Mariana, see Osorio & Fleig

Glawe, D. A., see Stiles & al.

Goos, R. D., see Hosagoudar and Goos

Gray, P. M., see Durán and Gray

Grgurinovic, Cheryl A., Studies on J. B. Cleland's fungal herbarium — 2: *Cortinarius* subgenus *Myxacium* (Cortinariales) 47-61

Heiny, Dana Kelly, *Phoma proboscis* sp. nov. pathogenic on *Convolvulus arvensis* 457-471

Hennebert, G. L., Book Reviews 483-491

Heykoop, M., see Moreno & al.

Ho, H. H., and S. C. Jong, *Halophytophthora*, gen. nov., a new member of the family Pythiaceae 377-382

Ho, H. H., and S. C. Jong, *Phytophthora erythroseptica* 73-90

Hosagoudar, V. B., and R. D. Goos, Meliolaceous fungi from the State of Kerala, India I 221-247

Illana, C., see Moreno & al.

Iturriaga, Teresita, and Richard P. Korf, A monograph of the discomycete genus *Strossmayeria* (Leotiaceae), with comments on its anamorph, *Pseudospiropes* (Dematiaceae). 383-454
Jacobsson, Stig, Studies on *Pholiota* in culture 95-145
Jakobsen, I., see Skou and Jakobsen
Jones, Nora, see Levetin & al.
Jong, S. C., see Ho and Jong
Klán, Jaroslav, Dana Baudišová, and Ivana Rulfová, Cultural, enzymatic and cytological studies in the genus *Pholiota* 249-271
Korf, Richard P., see Iturriaga & Korf
Kuthubutheen, A. J., see Nawawi & Kuthubutheen
Levetin, Estelle, Nora Jones, and Kerry Owens, A preliminary checklist of the Agaricales of Tulsa County, Oklahoma 337-342
Littlefield, Larry J., and Wanda K. Schimming, Size and shape of urediniospores as influenced by ambient relative humidity 187-204
Lorenzo, Laura, see Calvelo and Lorenzo
Loureiro, V., see Malfeito-Ferreira & al.
Malfeito-Ferreira, M., A. St. Aubyn, and V. Loureiro, Long-chain fatty acid composition as a tool for differentiating spoilage wine yeasts 35-42
Martínez, Angel T., see Checa and Martínez
Moravec, Jiří, A taxonomic revision of the genus *Cheilymenia* — 1. Species close to *Cheilymenia rubra* 169-186
Moreno, G., M. Heykoop, and C. Illana, Studies on *Galeropsis* and *Gastrocybe* (Bolbitiaceae, Agaricales) 63-72
Nawawi, A., and A. J. Kuthubutheen, *Nidulispora* gen. nov., a hyphomycete genus with crateriform conidia 329-336
Noel, G. R., see Stiles & al.
Osorio, Héctor S., Contribution to the lichen flora of Brazil. XXIII. Lichens from São Paulo City 161-162
Osorio, Héctor S., and Mariana Fleig, Contribution to the lichen flora of Brazil. XXIV. Lichens from Nova Petropolis, Rio Grande do Sul State 325-327
Owens, Kerry, see Levetin & al.
Rogers, Jack D., see Callan & Rogers
Rulfová, Ivana, see Klán & al.
Ryan, Bruce D., *Lecanora* sect. *Petrasterion* (lichenized Ascomycotina) in North America: *Lecanora weberi* Ryan, sp. nov. (subsect. *Pseudocorticatae*), from Colorado 9-14
St. Aubyn, A., see Malfeito-Ferreira & al.
Schimming, Wanda K., see Littlefield and Schimming
Skou, J. P., and I. Jakobsen, Two new *Glomus* species from arable land 273-282
Stiles, C. M., D. A. Glawe, and G. R. Noel, First record of *Catenaria auxiliaris* in Illinois 371-375
Tulloss, Rodham E., *Amanita eburnea* — a new species from Central America 1-7
Vanev, Simeon G., and Ganka G. Bakalova, Two new species of the genus *Ascochyta* Lib. 15-18
Vánky, Kálmán, Taxonomical studies on Ustilaginales. V 473-482

INDEX TO FUNGOUS AND LICHEN TAXA, VOLUME THIRTY-SIX

This index contains the names of genera, infrageneric taxa, species, and infraspecific taxa. New names are in **boldface,** as are the page numbers on which such new taxa are proposed.

Acarospora
  fuscata 13
Acaulospora 147, 148, 150, 157, 281
  appendicula 148, 150
  bireticulata 150
  delicata 150
  denticulata 150
  dilatata 150
  elegans 150
  foveata 150
  gdanskensis 149, 150
  gedanensis 149, 150
  gerdemanni 150
  gerdemannii 150
  lacunosa 150
  laevis 150
  longula 150
  mellea 150
  morrowae 150
  morrowiae 150
  myriocarpa 148, 149, 150
  nicolsonii 150
  polonica 150
  rehmii 150
  rugosa 150
  scrobiculata 150
  spinosa 150
  splendida 150
  sporocarpa 148, 150
  sporocarpia 148, 150
  thomii 150
  trappei 149, 151
  tuberculata 151
  undulata 151
Acrodontium
  antarcticum 91, 92
  crateriforme 92
Actinodothis 227
Agaricus 341
  abruptibulbus 339
  arvensis 339
  auricolor 339
  campestris 339
  graminum 19, 21
  lignicola 139
  vernalis 139
  xanthodermoides 339
Agrocybe
  dura 339
  pediades 339, 341
Allophylaria 283, 288-290
  byssacea 289
  clavuliformis 289
  cordobensis 289
  eucrita 289
  phyllophila 289
  senecionis 289
  sublicaeformis 289
  subliciformis 289
  terrigena 289
Amanita 5, 338, 341
  sect. Amidella 6
  sect. Phalloideae 1, 5
  aminoalifatica 6
  arkansana 339, 342
  bisporigera 5, 339
  citrina 339
  eburnea 1, 2, 4-6
  elliptosperma 5
  flavoconia 339
  flavorubescens 339
  fulva 339
  gwyniana 5
  hygroscopica 5
  inaurata 338, 339
  magnivelaris 5
  ovoidea 6
    var. ammophila 6
    var. proxima 6
  pantherina
    var. multisquamosa 339
  parviformis 5
  praegraveolens 339, 341, 342
  rubescens 338, 339
  thiersii 338, 339, 341, 342
  vaginata 338, 339
  verna 5, 339
  virosa 5, 338, 339
Amazonia 221, 224, 227, 229, 230, 236, 237
  acronychiae 221, **230**, 231
  actinodaphnis 221, **230**, 231
  peregrina 236
  philippinensis 236
  psychotriae 228
  syzygii 221, 232, **236**
Amphitrichum 228

Appendiculella 224, 227, 228, 242
  calostroma 228
  turpiniae 241, 242
Arachnopeziza 422, 423
  basitricha 415
Arhenia
  fimicola 180
Armatella 221, 224, 227-230
  cinnamomicola 237
  litseae 228, 237
Armillariella 341
  mellea 340
  tabescens 340, 341
Artallendea 228
Arthrinium
  fusiforme 416
Ascochyta 15-17
  subg. Ascochyta 16, 18
  subg. Libertia 16, 18
  boehmeriae 17
  digitalina 15, **17**, 18
  digitalis 17
  euphrasiae 18
  moelleriana 17, 18
  parietariae 16
  urticae 16
  urticicola 15-18
Aspicilia
  caesiocinerea 13
Asteridiella 221, 224, 227-230, 238-240, 242
  antidesmatis 239
  clerodendricola 221, 232, **237**
  combreti
    var. leonensis 238
  confragosa 238
  crotonis 221, 233, **239**
  cyclopoda 239
  drypeticola 239
  erythrococcae 240
  formosensis 240
  hansfordii 240
  macarangicola 221, 233, **240**
  malloti 241
  turpiniicola 221, 234, **241**
Asteridium 229

Belonidium 384, 430, 447
  albo-cereum 415, 422, 447
  album 400
  basitrichum 397, 408, 410, 412, 414, 421, 422
  fructigenum 415, 448
  glauco-fuligineum 448
  guttula 448
  helminthosporii 414, 418
  heterospermum 415
  immarginatum 428, 430
  introspectum 430
  japonicum 436, 449
  josserandii 436
  marchalianum 415, 418, 422
  marchandianum 415
  minutissimum 408, 415, 422
  pulvinatum 449
  rathenowianum 449
  tabacinum 450
Beloniella
  immarginata 428
Belonioscypha 295
  basitricha 415
  helminthicola 415
Belonium 296, 384, 408, 447
  alnicola 402, 404
  basitrichum 408, 415
  flocculum 448
  helminthosporii 408, 415
  sordidum 426, 441, 444, 446, 447
  sulphureo-testaceum 449
Beverwykella 329
Biatorina
  difformis 449
Bisporella 297
Boletus
  affinis 339
  bicolor 339
  fraternus 339, 342
  parasiticus 339
  variipes 339
Brettanomyces 36
Buellia
  contiguella 325, 326
Bulbothrix
  tabacina 161
Burenia
  cicuta 481
  inundata 481

Calloria
  myriospora 296
Caloplaca
  crocea 325
Calycellina 388
Calycina 283, 293-295
Cancellidium 329
  applanatum 332, 334, 335
Candelaria
  concolor 161
Candelariella 13
Candida 35
  vini 36, 37, 40

Catenaria
  auxiliaris 371, 372, 374
Catinaria
  versicolor 161
Ceratosphaeria
  quercina 449
Chalara
  antarctica 91, **92**
  microspora 92
  neocaledoniae 92
Cheilymenia 169, 171, 181
  alleghenensis 169, 180
  aurea 180
  coprinaria 171, 180
  fraudans 180
  humarioides 169, 171, 173, 177, 180, 181, 184
  liskae 169, **177**-181, 186
  magnipila 180
  megaspora 180
  pseudohumarioides 169, **173**-175, 177, 180, 181, 185
  rubra 169-173, 177, 179, 181, 183
Chiodecton
  sanguineum 161
Chlorophyllum
  molybdites 340, 341
Cintractia 476
  taubertiana 216
Cistella 288
  acuum 288
Cladonia
  ceratophylla 325
  subradiata 161
Claudopus 313, 321, 322
  mephiticus 313, 317, 320-322
  vinaceocontusus 313, 315, **316**, 319-321
Clavidisculum 288
Clitocybe 341
  gigantea 340
  nuda 340
  odora 340
  tarda 340, 341
  umbrinipes 340
Clitopilus
  prunulus 340
Collybia
  dryophila 340
  maculata 340
Conocybe
  lactea 339, 341
  tenera 339
Coprinus 99, 341
  comatus 339
  micaceus 339
  plicatilis 339, 341
  quadrifidus 339
  radicans 339
Coprobia 169
Cortinarius 142
  subg. Myxacium 47, 48
  sect. Archeriani 56, 57, 59, 60
  sect. Defibulati 52
  sect. Malvacei 54
  sect. Pyromyxae 49, 53
  stirps Iodes 57, 59, 60
    alboviolaceus 339
    archeri 48, 54-56
    austroalbidus 48, 53, 55
    bundarus 47, 48, 56, 58, **59**
    erythraeus 48, 51
    microarcheri 48, 55, 56
    ochraceus 52, 53
    paraochraceus 53
      var. australiensis 53
    ruber 48, 49
    sinapicolor 48, 51-53
    subarcheri 48, 56-60
    subarvinaceus 48, 50, 51
    violaceus 339
Couturea 229
Crepidotus
  mollis 339
Crocicreas 297, 299
Cronartium
  ribicola 148
Cryptocoryneopsis 334
Cryptocoryneum 334
Ctenoscypha 295, 296
Cyphella
  paraensis 409
Cystopezizella 283, 293, 295
Cytospora 43, 45
Cyttarophyllum 66

Dasyscyphus 288
  acuum 288
Diasporangium 379
Dictyonema
  glabratum 325
Dimelaena
  oreina 13
Diploschistes 327
  cinereocaesius 325, 326
Diporotheca 224
Dirinaria
  picta 161

Endogone 147, 148, 151, 157
  acrogena 151

- [Endogone] aggregata 151
  - alba 151
  - crassa 151
  - flammicorona 148, 151
  - incrassata 151
  - lactiflua 151
  - multiplex 151
  - oregonensis 151
  - pisiformis 151
  - reticulata 151
  - stratosa 151
  - tuberculosa 151
  - verrucosa 151
- Entoloma 313
  - clypeatum 340
  - mephiticum 320
- Entrophospora 147, 148, 151, 157
  - colombiana 151
  - infrequens 151
  - schenckii 149, 151
- Entyloma 473, 474, 480, 481
  - aristolochiae 473, 480
  - arnoseridis 474
  - atlantica 480
  - calendulae 474
  - crepidicola 473, 474
  - crepidis 473, 474
  - crepidis-rubrae 473, 479
  - debonianum 473, 480
  - erodianum 473, 480
  - flavum 481
  - geranii 480
  - glyceriae 473, 480
  - hieracii 473, 474
  - hydrophilum 473, 480
  - leontodontis 474
  - picridis 474
  - xanthii 473, 481
  - **zacintha** 473, **474**, 479
- Erinella
  - vermiicola 450
- Eubelonis 283, 295
  - albosanguinea 295

- Farysia 477
  - olivacea 476
  - thuemenii 473, 476
- Flammula
  - apicrea 135
- Flammulina
  - velutipes 340, 341

- Galeropsis 63, 64, 66
  - allospora 64
  - andina 63, 64, 66, 70, 71
  - angusticeps 64
  - bispora 63, 64, 66, 68, 71
  - **deceptiva** 63, **66**
  - desertorum 63-66, 71
    - var. **bispora** 63, 64, **66**
  - **lateritia** 63, **66**
  - liberata 64
  - madagascariensis 64
  - mitraeformis 64
  - plantaginiformis 63, 64, 66, 67, 71
- Gastrocybe 63, 64, 66
  - deceptiva 66
  - iberica 64, 66, 69, 71
  - lateritia 66
- Gigaspora 147, 148, 151, 157
  - albida 151
  - alborosea 148
  - calospora 273
  - candida 151
  - decipiens 151
  - gigantea 151
  - margarita 149, 152
  - ramisporophora 152
  - rosea 152
- Glomus 147, 152, 156, 157, 273, 280, 281
  - aggregatum 152
  - albidum 152
  - ambisporum 152
  - arborense 152
  - australe 152
  - boreale 152
  - botryoides 149, 152
  - caledonium 152, 273
  - callosum 152
  - canadense 152
  - cerebriforme 152
  - citricola 148, 152
  - citricolum 148, 152
  - claroides 149, 152
  - claroideum 149, 152
  - clarum 152, 281
  - constrictum 152
  - convolutum 152
  - delhiense 152
  - deserticola 148, 152
  - diaphanum 152
  - dimorphicum 152
  - dominikii 152
  - etunicatum 152
  - fasciculatum 152
  - fecundisporum 152
  - **fistulosum** 273, **274**-276, 280, 281
  - flavisporum 152
  - formosanum 152
  - fragile 153
  - **fragilistratum** 273, 275, **276**, 278, 280,

  281
  fuegianum 153
  fulvum 153
  geosporum 153
  gerdemannii 153, 280
  globiferum 153
  glomerulatum 153
  halon 153, 156
  halonatum 153, 156
  halos 156
  heterosporum 153
  hoi 153
  intraradices 149, 153, 156, 281
  intraradix 153, 156
  invermaium 149, 153
  invermayanum 149, 153
  lacteum 153
  leptotichum 153
  macrocarpum 149, 153
  maculosum 153
  magnicaule 148, 153
  manihot 149, 153
  manihotis 149, 153, 280
  melanosporum 153
  micraggregatum 148, 153
  microaggregatum 148, 153
  microcarpum 149, 153
  monosporum 153
  mosseae 149, 153, 273, 281
  multicaule 153
  multisubstensum 153, 156
  multisubtensum 153, 156
  occultum 153
  pallidum 153
  pansihalos 148, 153, 156
  pubescens 153
  pulvinatum 153
  pustulatum 153
  radiatum 153
  reticulatum 154
  scintillans 154
  segmentatum 154
  tenebrosum 154
  tenerum 154
  tenue 154
  tortuosum 154
  tubaeforme 154
  versiforme 154
  vesiculiferum 154
  warcupii 154
Glyphis
  cicatricosa
    f. confluens 161
Gorgoniceps 383, 384, 404, 427, 447, 449, 450
  alnicola 404
  aridula 447
  confluens 414, 423, 424, 427
  crataegi 408, 410, 412, 414
  iowensis 412, 415, 417, 419, 421-423, 427
  jamaicensis 432
  kirschsteinii 449
  kirschsteniana 449
  pilatii 388, 395, 415, 417-419, 422, 423
  pumilionis 423, 424, 427
  sambuci 404, 408, 410, 414
  taveliana 450
  verniicola 450
Guepiniopsis 291
Gymnopaxillus 163, 167
  crubensis 163, 164, 166, 167
  morchellaeformis 163, 166, 167
Gymnopilus 141, 142
  fulvosquamulosus 339
  junonius 140-142
Gyrodon
  meruloides 339

Halophytophthora 377, 379, **380**
  avicennae 377, **380**
  bahamensis 377, **381**
  batemanensis 377, **381**
  epistomium 377, **381**
  mycoparasitica 377, **381**
  operculata 377, **381**
  polymorphica 377, **381**
  spinosa
    var. **lobata** 377, **381**
    var. **spinosa** 377, **381**
  vesicula 377, **380**
Helicoma 29, 32
  sect. Helicoma 32
  ambiens 30, 32, 34
  muelleri 30, 32, 34
  taiwanensis 32
  vaccinii 29, 30, 32, 34
Helminthosporium 383, 384, 400, 408, 409, 412, 432
  apiculatum 416, 418
  belonidium 416, 422
  fusiforme 416
  fusisporium 416
  gongrotrichum 416, 421, 422
  gonyotrichum 416
  josserandii 436, 438
  nodosum 397, 406
  ostoyae 408, 410
  septemseptatum 432
  simplex 412

Helmisporium
  cylindricum 416
  simplex 416
Helotium
  albellum 290, 292
  drosodes 295
  subcarneum 295
Hemileia
  vastatrix 191, 198, 199, 201
Heterodermia
  lutescens 326
  vulgaris 326
Hyalinia
  albella 293
Hyaloderma 447
  bakeriana 408, 414
Hyaloscypha 289
Hygrophorus
  agathosmus 339
  conicus 339
  flavescens 339
  puniceus 339
  russula 339
  virgineus 339
Hymenoscyphus 285, 292, 294
  albella 293
  vulgaris 292
Hypoxylon 350
  atrosphaericum 349
Hypsizygus
  tessulatus 340

Inocybe
  fastigata 339
  napipes 339
Irene 228
Irenina 228
  turpiniae 242
Irenopsis 221, 224, 227-230, 242
  benquetensis 242
  eriolaenae 221, 234, **242**
  leeae
    var. **indica** 221, 235, **243**, 244
    var. javensis 243, 244
    var. leeae 243, 244
  tjibodense 243
  tortuosa 228
  triumfettae 244

Kretzschmaria
  atrosphaerica 349
Kuehneromyces 137, 139, 142
  mutabilis 249-251, 258, 263-267
  vernalis 139

Laccaria
  laccata 340
Lachnea
  humarioides 171
  rubra 170, 171
Lachnum 288
Lactarius 341
  chrysorheus 340
  oculatus 340
  subdulcis 340
  volemus 340
  yazooensis 340, 342
Laetinaevia
  myriospora 296
Lecanidion 400, 447
  album 400, 402
Lecanora 9, 13
  subg. Placodium 9
  sect. Petrasterion 9
  subsect. Pseudocorticatae 9
  muralis 13
  nigromarginata 9
  novomexicana 9, 10, 13, 14
  opiniconensis 9
  polytropa 13
  weberi 9, **10**, 13, 14
Leccinum
  rugosiceps 339, 342
Lecidea
  atrobrunnea 13
  oreinodes 326
Lentinellus
  ursinus 340
Lepiota
  americana 340
  procera 337, 340
Leptobelonium 383, 384, 397, 447
  helminthicola 415, 448
  sulphureo-testaceum 449
Leptogium
  cyanescens 326
Leucocoprinus
  breviramus 340
  luteus 340
  longistriatus 340
Leucostoma 45

Marasmiellus
  nigripes 340
Marasmius
  sect. Marasmius 26
  sect. Sicci 22
  alniphilus 26
  bulliardii 26
  capillaris 340
  curreyi 19, 22-24, 26

  exustus 22
  graminum 19-23, 26
  limosus 26
  oreades 340, 341
  pruinatus 22, 23
  rotula 26, 340
  siccus 340
  tritici 23
  wettsteinii 26
Melampsora 201
  abietis-canadensis 188
  lini 191, 193, 194, 197, 199, 202
  medusae 188, 191, 197, 199, 201, 202
  occidentalis 188
Melanelia 13
Melanoleuca
  meleleuca 340
Melanomma
  subdispersum 396
Melanopsichium
  pennsylvanicum 217
Melanotaenium 474, 475
  antirrhini 473-**475**, 479
  byzovae 473, 481
  cingens 474, 475, 479
  hypogaeum 474, 475
  jaapii 473, 475
  koschurnikoveanum 473, 475
  lamii 473, 475
Meliola 221, 224, 227-229, 242
  amphitricha 224
  asterinoides
    var. psychotriae 228
  floridensis 227
  groteana 236
  manihot 149
  tortuosa 228
  trichostroma 224, 229
Meliolaster 227
Meliolina 230
Mollisia 286, 292
Moriola
  descensa 396
Mycena
  leiana 340
Myridium 296
Myxothecium 229

Naematoloma
  fasciculare 340
Neottiella
  rutilans 212
Neovossia 476
  danubialis 473, 476
  iowensis 473, 476
  moliniae 473, 476
Neurospora 205, 206
  crassa 205, 207, 209, 213, 214, 217
  tetrasperma 207, 209-212, 214, 217, 218
Nidulispora 329, 332
  quadrifida 329, **330**, 333, 334
Niptera
  vulgaris 292

Omphalotus
  illudens 340, 341
Orbilia 296
Oudemansiella
  radicata 340, 341

Panaeolina
  foenisecii 339, 341
Panaeolus
  fimicola 339
  subalteatus 339
Panus
  rudis 340
  tigrinus 340
Parmelia 305, 306
  areolata 305, **308**
  astricta 309
  colensoica 305, **308**
  endochromatica 308, 309
  exillima 307
  festiva 305, 306, 310
  ganymedea 306
  geckonalis 306
  infausta 305, **306**, 307, 310
  inuncta 309
  lurida 308, 309
  ponderosa 305, **307**-310
  squamatica 309
  stenosporonica 308, 309
Parmelina
  muelleri 326
  pilosa 161
Parmotrema
  mellissii 326
  reticulatum 326
  sancti-angelii 162
  tinctorum 162, 326
Patellaria 440
  alba 400
Peltigera
  austroamericana 326
Penzigia 343, 350, 354, 368
  atrosphaerica 349, 350
  berteri 354
  enteroleuca 354
  indica 343, 358, 366, 368

Peronophythora 379
Pezicula 289
  byssacea 289
  clavuliformis 289
  eucrita 289, 290
  livida 289
  myrtillina 289
  phyllophila 289
  subliciformis 289
Peziza 288, 294, 408, 447
  'tribe' Mollisia 292
  adae 293
  albella 291-293
  albida 293
  atriseda 404, 406, 408
  avellanae 283, 288, 290-292
  eucrita 288-290
  firma 294
  helminthicola 397, 415
  helminthosporii 408, 415, 418
  herbarum 283, 293-295
    var. (unknown) 294
  heterosperma 396, 415, 417-423
  introspecta 430, 432
  minutissima 415, 432
  pallescens 293
  pineti 296, 447
  rubra 170, 171
  scutula 294
  sphaerioides 293
  sordida 290, 291
  sublicaeformis 288
  sublicoides 288, 290
  theleboloides 170, 171
    var. rubra 170
  urceolus 293
  vulgaris 283, 288, 290-293
Pezizella 283, 285, 287, 288, 290, 291, 293-297
  subg. Ctenoscypha 283, 295, 296
  subg. Eupezizella 295
  albella 291
  avellanae 285-288, 290
  conorum 292, 293
  dilutella 285-287
  dilutelloides 295, 296
  granulosella 286, 287
  helotioides 295
  juncina 285-287
  pulchella 285-288
  punctiformis 296
  rubella 285-287
  sordida 283, 285-287, 290, 292, 296, 297
  vulgaris 287, 288, 292, 296
Phaeographina
  caesiopruinosa 162
Phialea 286, 292, 293
  vulgaris 292
Phialophora
  dancoii 91, 92, **94**
  phaeophora 94
Phlyctella
  brasiliensis 162
Pholiota 95, 96, 98, 99, 104, 105, 118, 137, 141-143, 249-251, 265, 267
  subg. Flammula 142
  subg. Hemipholiota 119
  subg. Lubricula 122
  subg. Pholiota 142
  sect. Adiposae 250
  sect. Flammula 250
  sect. Hemipholiota 250
  sect. Lubricae 250
  sect. Pholiota 250
  sect. Subsiccae 250
  adiposa 96, 98-101, 104, 105, 108, 110-112, 114, 116, 118, 142, 143, 250-252, 258, 264-268
  albocrenulata 96, 104, 105, 138, 140, 143
  alnicola 96, 98, 100, 103-105, 133-136, 250, 251, 254, 260, 264, 266, 267
  astragalina 98
  aurivella 99, 110, 111, 114, 253
  carbonaria 122, 250, 253, 258, 264, 266
  conifera 250, 253, 254, 258, 264-267
  decussata 127
  destruens 249, 255, 260, 264-267
  erinceela 340
  flammans 98, 250, 255, 256, 258, 264, 266, 267
  flavida 250, 256, 257, 262, 264-267
  graminis 103-105, 132, 133, 142
  gummosa 96, 99, 103-105, 107, 130-133, 142, 250, 254, 257, 258, 264-268
  heteroclita 101, 104, 105, 118, 119, 142
  highlandensis 98, 102, 104-106, 120-122, 142
  jahnii 95, 98-101, 104, 105, 111-115, 137, 143, 250, 252, 259, 262, 264-266
  junonius 104, 105
  lenta 102, 104, 105, 125, 126, 128, 143, 250, 259, 262, 264-267
  lignicola 95, 104, 105, 138, **139**, 142
  limonella 96, 99-101, 104, 105, 108-111, 118, 143
  lubrica 102, 104, 105, 122, 127, 128, 142, 143
    f. lutea 127
  lucifera 96, 118, 143, 250, 256, 258, 259, 264, 266, 267
  mixta 100, 102, 104, 105, 124, 125, 128

  muelleri 114, 259
  mutabilis 99, 103-105, 136, 137, 139, 142, 263
  nameko 96, 98
  nematolomoides 98
  pinicola 98, 100, 103-105, 135, 136
  populnea 119
  scamba 102, 104, 105, 128, 129
  spumosa 100, 102, 104, 105, 122, 123, 125, 250, 252, 261, 262, 264-266
  squarrosa 101, 104-108, 110, 132, 142, 250, 260, 261, 264-267
  squarroso-adiposa 250, 256, 258, 263, 264-266
  squarrosoides 96, 101, 104, 105, 115, 116
  subcaerulia 340
  tuberculosa 98, 100, 103-105, 116-118, 142
Phoma 457, 458, 464
  sect. Plenodomus 464, 468
  americana 468
  capsularum 458, 466
  complanata 464
  convolvuli 458, 466
  dennisii 464
  eupyrena 468
  exigua
    var. exigua 464
  herbarum 466, 468
  lycopersici 464
  macrocollum 458, 464
  macrostoma 464
  medicaginis 464, 468
  minuta 458, 464
  multirostrata 466, 468
  pinodella 464, 468
  proboscis 457, **459**-461, 463, 464, 466, 468
  sepium 458, 466
Phyllopsora
  haemophaea 309
  pannosa 309
Phyllotopsis
  nidulans 340
Physoderma
  gerhardtii 473, 480
Phytophthora 74, 78, 79, 83, 84, 377-379
  avicennae 378, 380
  bahamensis 378, 379, 381
  batemanensis 378, 381
  cinnamomi 79
  cryptogea 79, 84-86
  drechsleri 74, 75, 79, 84, 85
  epistomium 378, 379, 381
  erythroseptica 73-86
    var. atropa 73, 74, 81
    var. drechsleri 74, 85
    var. erythroseptica 74
    var. pisi 74, 81, 82, 85
  fragariae 84
  himalayensis 74, 75, 81-85
  megasperma 74, 79, 83-86
  mexicana 84
  mycoparasitica 378, 379, 381
  nicotianae 75, 78, 79
  operculata 378, 379, 381
  palmivora 79
  pisi 85
  polymorphica 378, 381
  richardiae 84, 85
  spinosa 378
    var. lobata 379, 381
    var. spinosa 381
  vesicula 378, 380
Pichia 35
  membranaefaciens 36-40
Pileolaria
  brevipes 191, 197
Pleurophragmium
  cylindricum 416
Pleurotus
  ostreatus 340, 341
Pluteus
  cervinus 340, 341
  pellitus 340
Protomyces
  macrosporus 480, 481
Psammomyces 66
Psathyrella 341
  candolleana 99, 100, 339
  hydrophila 339
  velutina 339
Pseudocoprinus
  desseminatus 339
Pseudocyphellaria
  aurata 326
Pseudohelotium 283, 296, 297, 446, 447
  hyalinum 296
  pineti 296, 447
  puberulum 296
  sordidum 444
Pseudoparmelia
  caroliniana 162, 326
  texana 162, 326
Pseudopeziza
  albella 292
Pseudopyrenula
  diluta 162
Pseudospiropes 383-385, 388, 390, 394, 396, 397, 400, 402, 406, 408, 414, 420,

[Pseudospiropes] 421, 423, 427, 428, 430-434, 438-440, 442, 444
  josserandii 396, **436**, 439
  longipilus 396
  nodosus 394, 396, 399, 404, 408, 427, 428
  simplex 394, 396, 399, 400, 408, 410, 412, 414, 416, 420, 432, 438
Puccinia 188
  caulicola 191, 194, 195, 197, 199
  coronata 191, 193, 197
  graminis 187-189, 191, 193, 195, 196, 199, 200, 202
    f. sp. tritici 189
  helianthi 191, 195, 196
  minussensis 191, 197
  purpurea 191, 197
  recondita 187-189, 191, 193, 195, 197, 199, 200, 202
  sporoboli 191, 197, 199
  striiformis 189
  tanaceti 191, 196, 199
  tumidipes 191, 197
Punctelia
  constantimontium 326
  rudecta 162
Pythiogeton 379
Pythium 377, 379
  graminicolum 148

Ramalina
  celastri 326
Relicina
  abstrusa 326
Rhizoplaca 9
  chrysoleuca 13
  melanophthalma 9, 10, 13, 14
  subdiscrepans 13
Rhodocybe 313, 314, 316
 sect. Rhodocybe 316
  pallida 313, **314**-316, 319
  retroflexa 316
Rhodotus
  palmatus 340
Russula 341
  compacta 340
  foetens 340
  virescens 340

Saccharomyces 35
  bayanus 37
  cerevisiae 36-40, 205-208, 210, 211, 214, 217, 218
  delbrueckii 37, 40, 41
  elegans 37, 38, 40
  rosei 37, 40, 41
Sarcoscypha
  rubra 171
Satchmopsis 329
Schroeteria
  delastrina 210, 217
Schwanniomyces
  hominis 37, 40
Sclerocystis 147, 148, 154, 157
  clavispora 148, 154
  coccogena 154
  coremioides 149, 154
  dussii 154
  indica 154
  indicus 154
  microcarpa 154
  microcarpus 154
  pachycaula 156
  pachycaulis 148, 154, 156
  pachycaulos 156
  pakistanica 154
  rubiformis 154
  sinuosa 154
Sclerophthora 379
Scutellinia 180
 sect. Minutae 180, 181
 sect. Pseudocheilymeniae 181
  alleghenensis 169, **180**
  convexa 180
  crucipila 181
  minutella 180
  rubra 170
Scutellispora 148, 154
  alborosea 154
  auriglobа 149
  auriglobosa 149, 154
  auriglobus 149
  bipapillosa 156
  calospora 154
  coralloidea 149
  coralloides 149, 154
  dipapillosa 154, 156
  dipurpurascens 154, 156
  dipurpurescens 156
  erythropa 155
  fulgida 155
  gilmorei 155
  gregaria 155
  heterogama 155
  minuta 155
  nigra 155
  pellucida 155
  persica 155
  reticulata 155
  savannicola 148, 155
  tricalypta 155
  verrucosa 155

  - weresubiae 149, 155
- Scutellospora 147, 148, 154, 157
  - alborosea 154
  - auriglobа 154
  - calospora 154, 273
  - coralloidea 154
  - dipapillosa 154
  - dipurpurescens 154
  - erythropa 155
  - fulgida 155
  - gilmorei 155
  - gregaria 155
  - heterogama 155
  - minuta 155
  - nigra 155
  - pellucida 155
  - persica 155
  - reticulata 155
  - savannicola 155
  - tricalypta 155
  - verrucosa 155
  - weresubiae 155
- Sorosporium
  - caledonicum 216
  - cenchri 216
  - confusum 216
  - consanguineum 216
  - mixtum 216
  - penuriasorus 216
  - saponariae 217
- Sphacelotheca
  - andropogonis-hirtifolii 216
  - cruenta 216
  - diplospora 216
  - hydropiperis 216
  - monilifera 216
  - nealii 216
  - pamparum 216
- Sphaeria 229
  - calostroma 228
  - trichostroma 229
- Sporisorium
  - anthistirae 216
  - puellare 216
  - reilianum 211, 216, 218
  - rhynchelytri 216
  - sorghi 216
- Stamnaria 297
- Stereum 456
  - plicatulum 455, 456
  - plicatum 455, 456
  - spadiceum 456
    - var. plicatulum 455, 456
    - var. plicatum 455, 456
    - var. spadiceum 456
- Sticta
  - weigelii 326
- Strobilomyces
  - floccopus 339
- Stropharia
  - coronilla 340
  - melanosperma 340
- Strossmayeria 383-385, 387, 390, 394, 396, 398-401, 408, 410, 414, 420, 426, 427, 429, 434, 436, 438-440, 442, 445, 447-450
  - **alba** 383, 388, 392, 398, **400**-404
  - **alnicola** 383, 392, 395, 399, 401, **402**, 405
  - **atriseda** 383, 388, 391, 392, 395, 396, 399, 401, **404**, 407, 428, 434, 436, 440
  - **bakeriana** 383, 388, 391-393, 395, 396, 398, 401, 404, **408**, 411, 412, 414, 430, 438, 447
  - basitricha 388, 393, 395, 396, 398, 400-402, 404, 408, 410, 412, 414, 417, 419, 421, 423, 427, 432, 438, 448
  - brevitricha 415
  - **confluens** 383, 391-393, 399, 401, **423**, 425, 442
  - **dickorfii** 383, 392, 394, 396, 399, 401, **427**-429, 438
  - **immarginata** 383, 392, 398, 401, **428**, 429
  - **introspecta** 383, 388, 391, 392, 394, 395, 398, 401, **430**, 431
  - **jamaicensis** 383, 392-395, 399, 401, 426, **432**-434, 447
  - **japonica** 383, 388, 395, 399, 401, **434**, 437
  - josserandii 394-396, 398, 401, 436, 438, 439
  - longispora 392, 395, 408, 410, 414, 447
  - **nigra** 383, 388, 399, 401, **439**, 441
  - **notabilis** 383, 388, 391, 392, 394, 395, 399, 401, **440**, 442
  - **ochrospora** 383, 388, 391, 398, 401, **442**, 445
  - ostoyae 388, 391, 395, 408, 410
  - panamaensis 442
  - phaeocarpa 447
  - rackii 396, 415, 422, 423
  - **sordida** 383, 392, 393, 395, 398, 401, **444**, 445, 447
  - sphenospora 447, 450
  - viridi-atra 447

- Tapesia 408
  - atriseda 404, 406
- Thaxteriella
  - pezizula 34

Thecaphora
  hennenea 211, 216-219
Tilletia 189, 210
  aegopogonis 217
  barclayana 213, 216
  boutelouae 217
  brunkii 217
  buchloeana 217
  controversa 207, 210, 217
  durangensis 217
  horrida 213, 217
  hyalospora 473, 476
  indica 210, 217
  laevis 210, 217
  lycuroides 210, 217
  muhlenbergiae 217
  narasimhanii 217
  narayanaraoana 217
  obscura-reticulata 217
  rugispora 216
  trachypogonis 216
  tritici 210, 217
  tuberculata 216
  wilcoxiana 473, 476
Tolyposporium
  bullatum 216
  junci 216
  penicillariae 216
Torulaspora 35
  delbrueckii 36-38, 40, 41
Torulopsis
  colliculosa 37, 40
  stellata
    var. cambresieri 37, 40, 41
Trachysphaera 379
Trachysphaerella 378
Tranzschelia
  pruni-spinosae 191, 193, 196, 199, 201
Tricholoma 341
  columbetta 340
  virgatum 340
Tricholomopsis
  platyphylla 340
Tubeufia
  pezizula 30, 34
Tylophoron
  protrudens 162
Tylopilus
  felleus 339
  indecisus 339, 342
  pseudoscaber 339

Uredinopsis
  osmundae 191, 198, 199, 201
Uredo
  digitariae 473, 477
  panicorum 477
Urocystis
  colchici 216, 217
Uromyces
  appendiculatus 187-191, 193, 195, 196, 200, 202
  dianthi 188
  plumbarius 191, 195, 196
  silphii 191, 195, 196
  striatus 191, 193, 196, 199, 202
Urophlyctis
  crepidicola 473
Uropyxis
  amorphae 191, 197
Ustilago 476
  aegopogonis 217
  aschersoniana 216
  bethelii 216
  betonicae 216
  buchloës 216
  bullata 217
  cariciphila 473, 476
  convertere-sexualis 216
  cynodontis 211, 216, 218, 473, 477
  digitariae 477
  dumosa 473, **477**, 479
  elegans 217
  enneapogonis 217
  ixophori 216
  kuehneana 477
  minor 217
  neglecta 216
  opiziicola 216
  parlatorei 477
  scitaminea 216
  segetum
    var. avenae 217
    var. cynodontis 477
    var. segetum 211, 217, 218
  spegazzini
    var. agrestis 211, 217-219
  spermophora 216
  succisae 216
  trichophora 216
  tricuspidis 217
  violacea 211, 217, 218
  zeae 211, 216, 218

Valsa 45
Valseutypella 43, 45
  multicollis 43
  tristicha 43, 45

Xanthoparmelia 13, 306, 309
  areolata 308

511 31 for J. B. MORGAN read J. B. MORTON

  centralis 308
  colensoica 308
  farinosa 326
  lynii 307
  olivetorica 306, 309
  saleruptens 306
Xeromphalina
  campanella 340
Xylaria 343, 350, 354, 368
  adscendens 343, 344, 346
  allantoidea 343, 346, 348, 363
  anisopleura 350
  arbuscula 343, 349, 364
  atrosphaerica 343, **349**, 350, 352
  berteri 354
  coccophora 352, 361
  cubensis 343, 348, 349, 354, 362-364
  curta 343, 352, 354, 356, 360
  enterogena 343, 356, 358, 363, 364, 366
  enteroleuca 343, 352, 354
  feejeensis 343, 352, 358, 360
  hypoxylon 346
  mali 346
  microceras 343, 360, 361, 364
  nigrescens 348
  obovata 356, 361, 362
  papyrifera 363
  poitei 348
  polymorpha 362
  scruposa 350
  telfairii 343, 358, 363, 366
  tentaculata 343, 364, 366
Xylocoremium 363
Xylosphaera
  papyrifera 363
    subsp. cubensis 363

Zoophagus 379
Zygosaccharomyces 35
  bailii 36-41

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Page	284	line	16	*for*	arbitrarily	*read*	arbitrary
			34	*for*	possibilty	*read*	possibility
	287		9	*for*	death 1915.	*read*	death in 1915.
			32	*for*	typification	*read*	typifications
	288		10	*for*	doubts	*read*	doubt
			29	*for*	and contradictory:	*read*	and is contradictory:
			38	*for*	synoymized,	*read*	synonymized,
	289		6	*for*	supposed	*read*	suppose
			38	*for*	single of	*read*	single one of
	290		14	*for*	of of	*read*	of
			21	*for*	jodine-positive	*read*	iodine positive
	291		2,23,26	*for*	fruting	*read*	fruiting
			16	*for*	species	*read*	species,
	292		20	*for*	fruting	*read*	fruiting
	293		3	*for*	synoymized	*read*	synonymized
	295		36	*for*	alraedy	*read*	already
	296		11	*for*	jodine-positive	*read*	iodine-positive
			12	*for*	adequate to do not	*read*	not adequate to
			31	*for*	posthumous	*read*	posthumously
			38	*for*	arbitrarily,	*read*	arbitrary,
	297		6	*for*	akward	*read*	awkward
			9	*for*	transfered	*read*	transferred
			27,37	*for*	jodine-positive	*read*	iodine-positive
	298		37	*for*	with in	*read*	within
	322		6	*for*	local	*read*	locality
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